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·THE·EYE·  
·AND·IT'S·CARE·



·BY·


·FRANK·ALLPORT·M·D·

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FIG. 9.



The appearance of the interior of the back portion of a healthy eye, sometimes called the "fundus."

# THE EYE AND ITS CARE

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TO

CHARLES A. OLIVER, A.M., M.D.,  
OF PHILADELPHIA,

THIS LITTLE VOLUME IS MOST CORDIALLY AND  
RESPECTFULLY DEDICATED

BY

THE AUTHOR.



## PREFACE.

---

THIS little book is not intended for medical students or practitioners. It is written essentially for school-teachers, advanced pupils, and those interested in educational matters and ocular hygiene. To all such the writer trusts it may prove a useful assistant in the formation of correct ideas as to the anatomy and physiology of the eye, its uses and limitations, and as to what methods, tending toward a perpetuation of good eyesight in this and succeeding generations, may be advantageously adopted.

Great care has been taken to expunge everything technical or of an abstruse character, and to avoid, as far as possible, the use of scientific terms and expressions. Exacting anatomists and physiologists may criticise portions of the book treating of

such subjects; but it is hoped they will remember that these portions are written not for them, but for those requiring elementary and easily comprehended instruction.

Originality, either as to subject matter or pictorial illustration, is not claimed by the writer. An effort has been made to present the topic in a manner that may be readily understood; and wherever it has been found necessary to borrow ideas or illustrations, it has been done.

Trusting that the book will accomplish the purpose for which it was written, the writer begs the kind indulgence of its readers for any manifest shortcomings.

FRANK ALLPORT.

602 Nicollet Ave., Minneapolis, Minn.

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# THE EYE AND ITS CARE.

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## CHAPTER I.

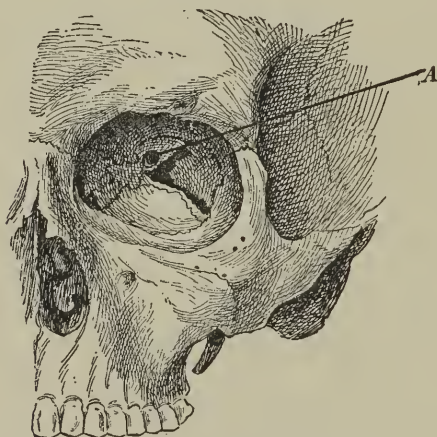
### ANATOMY AND PHYSIOLOGY.

THE eye is a globular body composed of certain coats, and humors of a more or less fluid consistency. Providence has blessed us with two such organs, which is a fortunate provision when their delicacy and ease of irreparable injury are remembered.

The eye rests in a bowl-shaped socket, which is composed of portions of several bones of the skull, joined together. In the rear of the socket are some openings, one of which, called the optic foramen, serves principally for the admission of the optic nerve as it passes from the brain to the eye. The socket is lined by certain membranes and other tissues, serving as a soft and yield-

ing bed in which the eyeball, without impairing its integrity, rests and moves. Among these tissues is found a double membrane, originating in the posterior portion of

FIG. 1.



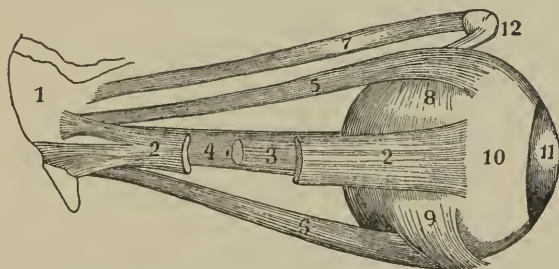
Section of the skull showing the orbit or socket in which the eyeball moves: *A*, optic foramen through which the optic nerve passes.

the socket. Passing forward, it envelops the eyeball, being loosely attached to it at its circumference. It then doubles on itself, passes backward, and becomes reattached near the point of its origin. This



membranous sac is called Tenon's or Bonnet's capsule, and forms a concavity in which the eyeball is held in a manner analogous to what is known as a ball-and-socket joint.

FIG. 2.



1, piece of orbital bone; 2, external straight muscle, with piece cut out; 3, optic nerve; 4, internal straight muscle; 5, upper straight muscle; 6, lower straight muscle; 7, upper oblique muscle, attached to ball at 8; 9, lower oblique muscle; 10, sclerotic; 11, cornea; 12, pulley for tendon of upper oblique. (Gray.)

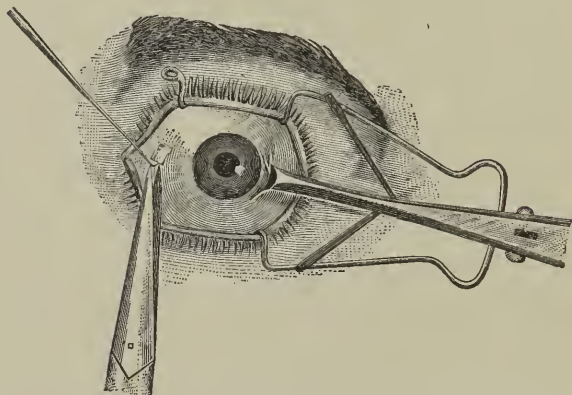
The eye is moved in different directions by six muscles. Four of these are known respectively as the superior rectus, which is attached at the upper portion of the globe; the inferior rectus, which is attached at the lower portion; and the internal rectus and external rectus, which are attached severally

at the inner and outer portions of the eyeball. Besides these, there are the superior and inferior oblique muscles, which are attached at the outer portion of the eyeball. With the exception of the inferior oblique, they all originate around the optic foramen, at the extreme rear of the orbit, and, passing forward through the tissues of Tenon's capsule, become attached as just described. The inferior oblique muscle originates in the lower inner and anterior portion of the orbit, passes along sideways under the inferior rectus, to become inserted under the tendon of the external rectus, thus partially encircling the globe. The superior oblique, after originating near the optic foramen, runs forward and inward, and passes through a little pulley at the upper and inner part of the orbital edge. It then turns outward over the upper portion of the globe, under the superior rectus muscle, and is fastened or inserted at the upper and outer part of the eyeball.

These are the muscles which move the eye in almost every conceivable direction. The principal movement obtained by the superior rectus is in an upward direction; by the inferior rectus, downward; by the internal rectus, inward; by the external rectus, outward; while the oblique muscles impart principally oblique or rotary impulses and movements to the eyeball. A shortening or contraction of one of these muscles is frequently the cause of cross-eye, or strabismus, as it is technically called. Thus, if the internal rectus muscle is shortened or contracted, the eye turns in, producing a condition familiar to the reader. If the external rectus muscle is shortened, the eye turns out, producing "wall-eye," as it is commonly denominated. These unfortunate conditions, if not corrected by glasses, are remedied by cutting the conjunctiva or enveloping membrane of the anterior portion of the eyeball, picking up the contracted muscle with a hook, and

severing it from its attachment, thus enabling the eye to assume its proper position.

FIG. 3.



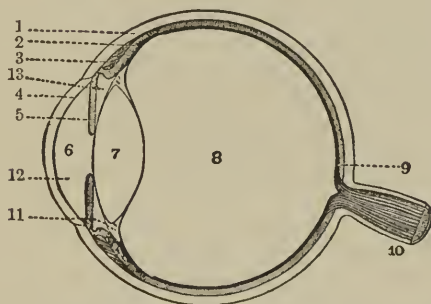
Shows the operation for "cross-eye" or strabismus. The eyeball is being steadied by a pair of forceps; the conjunctiva has been cut, the tendon of the internal rectus muscle drawn out on a hook, and the scissors are just about to sever the tendon.

The eyeball proper is composed of three coats, each of which performs essential functions in its healthy or physiological condition.

The outer coat of the eye is called the sclerotic, and is hard, tough, and unyielding. It is the skeleton of the visual organ, for

without it the eye could not maintain its shape, as it is the only firm membrane concerned in its composition. It is white and glistening in appearance, and is indicated

FIG. 4.



Vertical section through the eyeball: 1, sclerotic; 2, choroid; 3, ciliary muscle; 4, cornea; 5, iris; 6, aqueous humor; 7, lens; 8, vitreous humor; 9, retina; 10, optic nerve; 11, ciliary or suspensory ligament; 12, anterior chamber; 13, posterior chambers.

when reference is made to the “white of the eye.” To this coat are attached all the muscles which move the eye, and, in fact, it may be said, with reasonable accuracy, that all of the tissues, membranes, muscles, etc., which serve to operate the ocular functions, are attached, either directly or indi-

rectly, to this coat. Veritably it is the framework upon which the eye is constructed. It practically surrounds the eyeball on all portions of its circumference, and in the rear is continuous with the outer sheath of the optic nerve, as the sheath passes through the optic foramen on its way to the cavity of the brain. Even here it is still continuous with the dura mater, or outer enveloping membrane of the brain substance. In front the sclerotic coat passes (with some changes in its structure) into what is known as the cornea, so it will be seen that the entire outer membrane of the eye is in reality simply an extension outward of the dura mater of the brain. When the sclerotic merges into the corneal tissue, it loses those elements in its composition which render it opaque, and in this position becomes transparent and colorless. The cornea itself projects from the general contour of the eyeball like a bay-window from a house, or a glass crystal from the face of a watch,

which, in reality, it resembles. It is best seen in profile, for when viewed from in front the underlying iris is merely brought in view. It is the "window of the eye" through which one sees, and, as its surface is limited and its function so important, the utmost care must be taken to preserve its brilliancy and transparency. As, in order to obtain the best view of objects when looking through a window-pane, it is necessary that the glass be of superior quality, flawless, and unspotted by dirt, frost, etc., so it is with the cornea: it must be as perfect as possible in order to secure good visual results. Hence it is upon account of damage to the cornea that ocular injuries, inflammations, etc., are fraught with so much danger, for if the corneal membrane is roughened, scarred, or impaired, its usefulness will be correspondingly diminished. Therefore, no ocular trouble is insignificant when its possible effect upon the cornea is considered; and conditions which in other parts of the body

would be hardly noteworthy, here become of the utmost importance. For instance, take a little scratch or ulcer; if it is on the hand, face, or elsewhere, it attracts little or no attention, but should it be situated on the cornea it may assume the utmost gravity. Especially is this so if such conditions spread, and do not quickly disappear, allowing at times the entire membrane to become involved. In any case, when healing occurs, a white scar will nearly always indicate the seat of disease, and proportionately to its extent, position, and density, impair vision. If such a scar occurs directly over the pupil, central vision will be greatly impaired. If it be situated upon one side of the membrane, the visual result will not be so disastrous. The rest of the eye may be normal, yet if the integrity of the cornea be impaired, correct vision may be impossible.

Passing inward from the sclerotic the next coat is the choroid, and in this coat is found a material of an entirely different



character. It is dark in color and fragile in consistency. It is composed almost entirely of blood-vessels, and consequently performs the physiological function of supplying nourishment to many portions of the eye, which are otherwise poorly supplied with material sufficient to maintain life. It does not extend back into the brain cavity, but originates in the extreme rear of the eyeball, at the entrance of the optic nerve. At its point of origin it is circular, extending around the optic nerve. From here it spreads out on all sides and lines the sclerotic, to which it is firmly attached at its anterior and posterior portions. As the choroid approaches the anterior portion of the eyeball, its tissues become folded upon themselves in plaits, spreading circularly forward from the central anterior portion of the interior of the globe, like radii around the sun. These duplications are called the ciliary processes, and as they pass forward they become thicker and more muscular

in nature, until at last they are merged into what is known as the ciliary muscle, or the muscle of accommodation, whose physiological function will be referred to in describing the crystalline lens. The ciliary processes and ciliary muscle together are called the ciliary body, but, in reality, they are all a mere continuation of the choroid. At the extreme anterior portion of the ciliary body, its tissues become thin, change somewhat in character, drop down into view, and are then known as the iris. The three parts, the choroid proper, the ciliary body, and the iris, are sometimes classified under the general name of the uveal tract.

It is the iris which gives color to the eye and largely imparts expression to the face. Some people have blue, others brown eyes, etc., circumstances which are due to the amount of coloring that is imparted to the iritic tissues. These differing shades are usually consistent with the general color tendency of the individual; as, for instance,

blondes generally have blue, and brunettes, brown or black eyes. The iris of a young Caucasian infant is always blue. The iris of an albino possesses little or no coloring matter, and hence forms but a meagre barrier to the free inspection of the interior of the globe. Owing to the lack of color in the eye of an albino, and the consequent easy admission of light, not only through the pupil, but through the almost transparent iris itself, together with the fact that the choroid is almost devoid of color (thereby occasioning great confusion of vision), the sight of these peculiar "pink-eyed" individuals is necessarily defective, and, not being provided with the usual defence against excesses of illumination, their eyes are exceedingly sensitive to light.

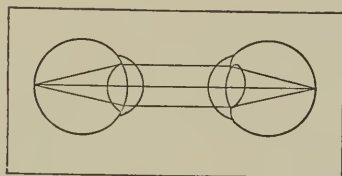
The centre of the iris is pierced by a round opening called the pupil, which is enlarged and contracted intuitively, by muscular tissues contained in the meshes of the iris. If an individual enters a dark room, the desire for more light is instinctive;

consequently, the pupil becomes widely expanded in order to enhance intraocular illumination. If, on the contrary, the sun or other bright light be faced, the muscular fibres produce pupillary contraction, thus excluding detrimental and annoying rays of light. This is a physiological function which is accomplished without volition, and is a beautiful illustration of the marvellous action of the different portions of the body.

The pupil is simply a hole in the iris, that is similar to the perforation made by a conductor's punch in a piece of cardboard, and not, as many people believe, upon account of its darkness, something that is substantial. It appears black because of the lack of intra-ocular illumination, just as the open door-way to a dark closet is black for essentially the same reason. If in the latter case daylight be allowed to pass through any portion of the closet walls or if we stand upon the threshold of the closet with a lighted lamp in our hand, the black area of the

door-way is lost and the contents of the closet are revealed.

FIG. 5.



Shows the interchange of light rays between the eye of an observer and of the observed.

An interchange of light rays between the eye of an observer and the object observed is essential to perception, this statement presupposing illumination of the object. Surface objects are therefore easily perceived, while those that are contained in unilluminated spaces are invisible; consequently, the pupil of the observed eye appears black, and the interior of the globe is invisible, through lack of intra-ocular illumination occurring in the track of the observer's eye, this being impossible unless the observing eye is located directly in such illumined track. To illustrate: if a lamp is held between the eye of the observer and the observed eye, it

will prevent an interchange of light rays between the two organs. Again, if the lamp is held back of the observer's head, the illumination proceeding therefrom will not reach the observed eye. Therefore, we cannot view the interior of another person's eye because we cannot utilize ordinary intraocular illumination.

The interior of the living eye was as a closed book until the genius of von Holmholtz inspired the practical conception of the ophthalmoscope. By the use of this instrument, the greater portion of the inside of the eye can be inspected with as much closeness and accuracy as the outside, and the intraocular lesions of many diseases that had heretofore been misunderstood were disclosed by this search-light of ophthalmology. We cannot see into the interior of the eye without this instrument, because we are always in our own light, as it were, but the principle upon which the ophthalmoscope is constructed obviates this difficulty.

The ophthalmoscope is simply a little mirror with a hole situated in its centre.

FIG. 6.



Shows the back of the ophthalmoscope.

The observer and patient sit facing one another in a dark room, with a strong steady light placed at the side and a little in the rear of the latter's head. The observer takes the instrument, places it in front of his eye, with the mirror toward the light

FIG. 7.



Shows the perforated circular concave mirror in the front of the ophthalmoscope.

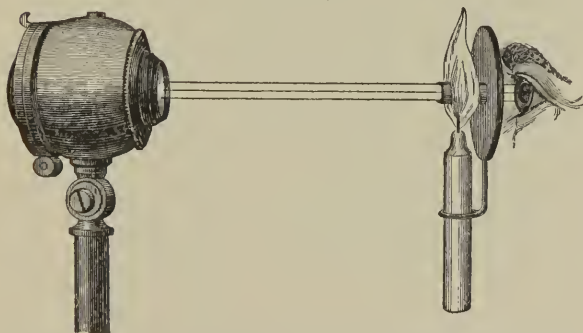
and the patient, and looks through the central perforation. If this be done properly,

the pupil, which but a moment before was black, becomes red, as the red reflex of the choroid, shining through the nearly transparent retina, is brought to view. From this simple beginning, the complexities and beauties of a thorough ophthalmoscopic examination can be obtained by patience and skill. To suit the exigencies of each case, there is a system of changeable lenses situated behind the mirror, by means of which the interior of the eye may be made more plainly visible, and the optic nerve, choroid, vessels, veins, etc., all as accurately observed as if they were placed in the palm of the open hand. The explanation for this is simple and obvious. Rays of light proceed from the lamp to the mirror, which is held in front of the observer's eye, and through which he looks, by means of the central perforation. The light rays are then transmitted from the mirror to the observed eye, and, after passing through the pupil, strike the retina, from which they rebound and pro-



ceed back to the mirror, through the perforation and through the observer's pupil to *his* retina, thus inducing visual perception. It will therefore be noticed that, inasmuch as the eyes of the observer and the observed are mutually located in the track of the unobstructed light rays, rendered clear by means of the lamp and the location of the

FIG. 8.



Shows how the interior of the eye may be seen through the flame of a candle. (Loring.)

observer's eye behind the perforated mirror, there is no reason why the intra-ocular structure of the observed eye should not be visible to the eye of the observer. The same

thing would be accomplished if the eye of the observer was located directly in a flame, or behind a hollow tube immersed in a flame, held between the observer and the observed.

FIG. 10.



Relative position of patient and observer during the so-called indirect method of ophthalmoscopic examination.

The examination of the interior of the eye is much facilitated by placing a few drops of belladonna or of its active principle, atropine, upon the conjunctival sac. The

drug paralyzes the muscular fibres which contract the pupil, thereby producing a pupillary dilatation, and a consequent enlargement of the opening through which the examination is made.

The retina is the third and innermost coat of the eye, and in importance yields precedence to neither of the other two coats. It is the perceptive coat, without which nothing could be seen. In reality it is an expansion of the optic nerve, by means of which impressions are transmitted to the brain. It is a veritable continuation of brain substance into the eyeball, and, as the sclerotic coat is a prolongation of the dura mater, so the retina takes its origin in the brain. It extends forward as the optic nerve proper (enclosed in an enveloping sheath), passes through the optic foramen, and, after entering the eye, is spread out in a fan-like fashion, lining the interior of the globe, until it becomes lost in the neighborhood of the ciliary body.

In order that the retina may fulfil its destiny, a thorough integrity of its tissues is indispensable. If any portion of its structure (within range of vision) be impaired, sight becomes correspondingly deficient. The retina corresponds to the paper on the walls of a room, and, like wall-paper, it sometimes becomes loosened from its underlying attachment and forms a kind of blister. This is called detachment of the retina, and is a disease that is incident to many cases of extreme myopia, producing practical blindness wherever such detachments occur. There are many other retinal diseases, which it is not the province of this book to enumerate, that impair the integrity of the retina and that are accompanied by a greater or less loss of vision. Such diseases may occur in circumscribed "spots," giving rise to corresponding "blind areas" before the eye, or may involve the entire membrane, in which event a general defect of vision follows.

The retina corresponds to the delicate film

which receives the impression of an object and allows it to become stamped upon its surface in a photographer's apparatus. The entire eye, in fact, closely resembles a camera, and, like the camera, is intended to "take pictures." There is the sclerotic, corresponding to the box or shell of the apparatus, forming a firm and substantial framework; the choroid, forming a background, like the black lining to the camera, and absorbing any excessive light, which, by reflection and diffusion, would prevent accurate vision; the retina, corresponding to the film of the camera, upon which the impression is retained; the pupil, corresponding to the opening in the front of the camera, through which the aerial impression of the object passes; and there are the lens and the aqueous and vitreous humors, each and all corresponding to similar refracting media in the box of the photographer. Striking comparison; wonderful similarity; undoubtedly the art of photography was conceived from

that most marvellous camera of nature, the physiological eye!

The retina, however, is dissimilar to the camera's film in one important particular,—that is, it is not limited to one clear impression. Its capacity is, in a sense, infinite. Whenever an object is looked at, a picture is made on the retina, which is dissipated in the fractional part of a second, to make room for another. The lightning-like rapidity of this phenomenon is almost incredible, and yet it is known that it exists. At times, however, these impressions are not so quickly removed, as the eye, although turned away from an object upon which it has been fixed, may occasionally retain the impression. For instance, if one looks intently at an incandescent light and the gaze be turned elsewhere, the white loop of light may still be seen. This phenomenon is supposed to be the explanation of Macbeth's remark when he said, "Is this a dagger which I see before me?" As may be remembered, he

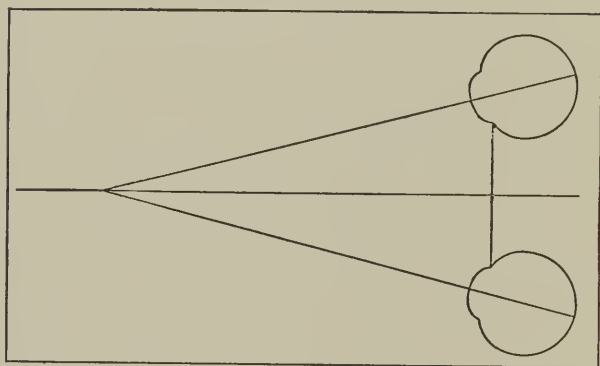
had been standing, holding the weapon in his hand, with his gaze fixed intently upon it, when suddenly he lifted his eyes and thought he saw a dagger floating in the air. Undoubtedly this was meant by the great writer to represent an unabsorbed retinal impression.

In the fertile brain of a French novelist, some years ago, was developed the theory that the picture of a murderer may be found upon his victim's retina,—and, in view of the wonderful progress in other branches of knowledge, it may not be impossible that ante-mortem retinal impressions may some day play an important part in the detection, conviction, and punishment of criminals.

The most sensitive part of the retina,—the point admitting of the most perfect vision,—is a spot that is situated directly in the axis of vision. It is called the “yellow spot,” because here, after death, the retina assumes a yellowish tinge. This is the spot to which the eye naturally seeks to direct

rays as they enter the globe, and unless success in this endeavor be obtained, perfect vision is impossible. Consequently, the eye continually moves from one position to another, seeking to focus the rays that pro-

FIG. 11.



Shows how single vision is produced by the proper and simultaneous use of both "yellow spots."

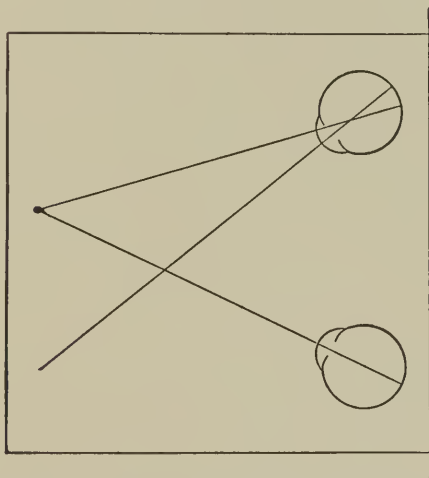
ceed from objects, not only on the retina, but, still better, on the yellow spot. However, to obtain normal binocular vision, it is necessary to focus rays simultaneously upon both yellow spots. The accurate focussing



must be accomplished in both eyes at one and the same time.

In this way binocular vision, or vision with both eyes, is obtained,—in contra-dis-

FIG. 12.



Shows how double vision is produced when the right eye is turned in or converged, and the image emanating from the right "yellow spot" is thrown off to one side.

tion to monocular vision, or vision with only one eye, where the other is blinded or obscured. The reason that binocular vision

is much better and more satisfactory than monocular is that more sides of an object are seen, and the impressions become more comprehensive.

It may be asked, inasmuch as both eyes receive an impression of an object, why are not two images seen instead of one? In fact there are, but when these two impressions are exactly focussed upon the yellow spots, they become merged into one; that is, if the object is not held so near as to render it impossible for the eyes to bring the two foci on the two yellow spots at the same time. If with both eyes one looks at his finger at a distance of two or three feet, and then gradually brings it toward his face, he will, at a certain point, find it impossible to longer merge the two images into one: he will see two fingers. The point at which two fingers became visible is the place at which it became no longer possible to converge the eyes sufficiently to focus the image of the finger upon both of the yellow spots

at one and the same time. When double vision is obtained in this or any other manner, it is called diplopia. Owing to insufficient power of certain of the ocular muscles, many people are naturally diplopic. They overcome this tendency, however, and obtain binocular vision by great taxation on the part of the weakened muscles. This increased action produces much pain and discomfort, and sometimes requires great skill to overcome, either by an operation upon the muscles, by the fitting of glasses, or by other treatment.

It is generally supposed that in these phenomena are to be found the causes of "cross-eye" or strabismus. In such cases there is a tendency to diplopia or double vision, with a perpetual effort on the part of nature to merge the two images into one, and produce binocular vision. The task becomes so difficult and constant, that, as a result, the eyes soon give up the effort, and one eye turns aside, and thus becomes "crossed."

There are three humors or fluids of the eye,—viz., the aqueous, the crystalline lens, and the vitreous. By some anatomists the crystalline lens, owing to its hardness, is not called a humor, but for purposes of convenience this classification will be adopted.

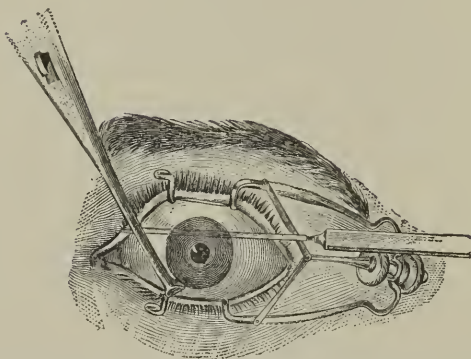
The aqueous humor is situated in the anterior part of the eye, occupying the space between the cornea and the crystalline lens. The iris drops into the fluid like a curtain, and divides the space into two portions which are called the anterior and posterior chambers. The former is situated between the cornea and the iris. The latter is located between the iris and the lens. In reality they are one chamber with a free interchange of fluid through the pupillary space between the two portions. The aqueous humor, as its name implies, is of watery consistency, possessing the fortunate ability, after being partially or wholly lost, of becoming reproduced with great rapidity. The importance of this phenomenon can be realized when the

delicacy of the cornea is remembered and how easily this membrane is ruptured. After a rupture nothing can prevent the escape of the aqueous humor through the corneal opening. If the humor did not become resupplied, the usefulness of the eye would be lost, through a joining together of the anatomical parts of the anterior portion of the globe, by adhesive inflammation. It must also be remembered that many of the most important operations on the eye involve a loss of aqueous humor during their performance, as, for instance, in the operation for the removal of a cataract, which by some people is thought to be an opacity of the cornea, instead of what it really is, an opacity of the crystalline lens. The removal of a cataract simply consists in removing the lens, and not in scraping away the opacities or incrustations that are sometimes observed on the cornea.

To accomplish this result, it becomes necessary to cut into the eyeball by way of

the cornea and the anterior chamber, and

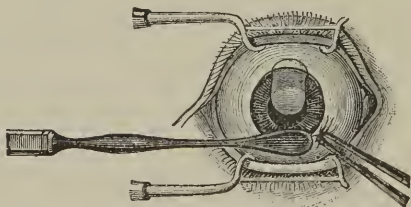
FIG. 13.



Shows an operation for cataract. The knife is seen passing through the anterior chamber.

then to remove the lens, in order to do away with this obstruction to vision, which

FIG. 14.



Shows a later step in the operation for cataract. The opaque lens is just being expelled.

procedure involves a complete loss of aque-

ous humor. This loss, however, as just said, fortunately is reproduced as soon as the corneal wound heals, which occurs in about thirty-six or forty-eight hours. To a layman the removal of a *l  ns* may appear equivalent to the destruction of sight, but, if the other portions of the eye are in healthy condition, good vision may be obtained by wearing in a spectacle frame a strong convex glass of a focussing power closely approximating that of the removed convex crystalline lens. \*

Just back of the aqueous humor is situated the second humor of the eye, viz., the crystalline lens, which is enclosed in a transparent and elastic capsule or envelope. The lens in its capsule is suspended at all portions of its circumference by a ligament that is called the ciliary or suspensory ligament. The ligament itself originates in the meshes of the ciliary body, and is firmly inserted at the circumferential edge of the lens capsule. The posterior portion of the lens is lodged

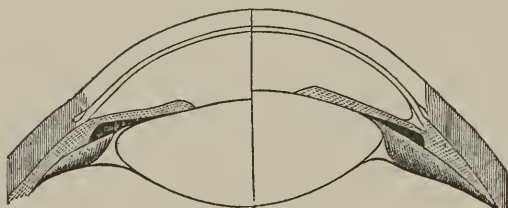
in a cup-shaped concavity in the anterior portion of the vitreous humor. The lens is a semi-solid double-convex body, shaped like a magnifying glass, capable of contraction and expansion by the action of the ciliary muscle and ligament. The ciliary muscle is sometimes called the muscle of accommodation, from its power of accommodating the eye to all distances and dimensions of objects. Were it not for this power, the eye would be like any other unvarying optical apparatus, capable of clear impressions at only exceedingly circumscribed limits. Take, for instance, a powerful magnifying lens of (say) three-inch focus; place it before the eye, and any one with a knowledge of optics will know that the object at which gaze is fastened must be brought up to just three inches from the lens, in order to produce a focus. If the lens is moved farther away, or if it is brought closer than three inches, a blurred image will be obtained. Or, if the same lens be taken and placed between the



sun and a piece of paper, it will have to be situated just three inches away from the paper, in order to focus the rays of light which pass through it. Imagine an opera-glass, a microscope, or a telescope with an unvarying focus or, in other words, without any screw or other device by which the instrument can be set for differing distances of objects: their uses would be very circumscribed; for, as just hinted, it is necessary, in order that they may be useful, that they possess mechanism and adjustments by which objects of different sizes and distances can be focussed and clearly seen. So it is with the eye, which would be comparatively useless if it possessed the power of focussing only at one distance, and could not be accommodated or focussed instantaneously upon any object at which the gaze is fastened. What the little adjusting screw is to the opera-glass, the microscope, and the telescope, the ciliary muscle and ligament are to the eye. If the individual wishes to

look at a small or near object, the ciliary muscle, or muscle of accommodation, contracts, which allows the ciliary ligament, connecting the ciliary muscle and the lenticular capsule, to become slack, which, in its turn, permits the lens fibres to give way to their elasticity, thereby forcing the lens into a state of increased convexity.

FIG. 15.



Shows the process of accommodation. In the left side of the picture the lens is in a normal condition, in the right side it has been forced into a condition of abnormal convexity by the action of the ciliary muscle.

Thus, the power of the lens is increased, and small and near objects become distinctly visible. It is like compressing the sides of a rubber ball, which resumes its most convex and normal position when such pressure is removed. By this delicate adjustment,

which is partly voluntary and partly involuntary, the eye becomes exceedingly useful and capable of wide and accurate functions, which are performed more quickly than the rapidity of thought. This can be readily understood when it is remembered that the focus of the eye changes every time that it looks from one object to another, and we all know with what rapidity this is accomplished every moment of our lives. Truly the "eye is a wonderful structure," and when it is analyzed in all of its delicate and exact complexities, we are inspired to say that "it passeth human understanding," and that it can hardly take its origin in accident or evolution.

Just back of the crystalline lens is located a large globular body, which occupies about two-thirds of the contents of the eyeball; this is called the vitreous humor. It is of about the consistency of very thin jelly, and is enclosed in a delicate envelope, called the hyaline membrane. When once it is lost by,

rupture of the enveloping coats of the eye, it is never re-formed; this being the accident which occurs when "the eye runs out," as it is graphically described by the laity.

It is the vitreous which is largely responsible for the form that is maintained by the eye, and without it the globe would collapse into a shapeless mass. In addition, by its inward pressure, it keeps the retina and choroid in position, and thus serves to maintain the proper relation and location of the other inner structures of the eye.

It is almost unnecessary to state that the cornea and humors of the eye must be maintained in a condition of absolute transparency, in order to obtain clear vision. Any deviation from this rule will be followed by a corresponding deterioration of sight; especially is this so if such deviation exist directly in the axis of vision.

The eyebrows are composed of thickened tissue, covered by coarse short hair. They serve the useful purpose of protecting the

eye from perspiration as it trickles down the forehead,—acting as a roof to a house, as it were, in shedding moisture. They also serve to impart expression and beauty to the face. This can be well understood when it is considered what varying emotions may be expressed by raising and lowering them, or bringing them together, as during the act of frowning.

The eyelids are divided into the upper and the lower. The opening between them through which the eye appears is called the palpebral fissure. Most eyes are about the same size, but they appear larger or smaller in accordance with the size of the palpebral fissure. Some think that their eyes are shrinking away, when, in reality, the opening between the lids, by reason of some weakness or disease, is smaller than normal, thus presenting the appearance of a diminished size of the eyeball. At each end of this elliptical aperture, there is an angle which is called, respectively, the internal

canthus and the external canthus; the former being towards the nose, and the latter toward the temple.

The lids move over the eyeball and tend to protect it from injury. Such movements are performed, however, almost exclusively by the upper lid, as the lower one remains practically motionless. The edges of the lids are bordered by a fringe of hairs, called the eyelashes. These curve in a manner that tends to best subserve the purposes of usefulness and beauty. In a measure they act to protect the eye from the invasion of foreign bodies, such as sand, dust, cinders, perspiration, etc. Their loss, which sometimes occurs, gives the face a peculiarly barren and unsightly appearance.

Sometimes the eyelashes become misdirected in their growth. They turn inward and scrape the eyeball as the lid moves over its surface. This process produces much pain and discomfort, with consequent disease. The condition is commonly known

as "wild hairs,"—the lashes being pulled out from time to time, as they irritate the eyeball. It may be a relief to those who are thus afflicted to know that the disease can be cured by a suitable operation.

The upper eyelid hangs from the bony or orbital ridge over which the eyebrow is inserted. The outer covering is composed of skin, which is continuous with the integument of the body, and which ends at the edge of the lid where the lashes grow. The inner lining of the lid consists of mucous membrane and is known as the conjunctiva. It is thin and almost colorless, except when reddened by inflammation. It extends from the edge of the lid to its extreme inner surface, whence it is reflected on to the eyeball. Here it rests over the sclerotic, and becomes attached around the circumference of the cornea. The conjunctival mucous membrane is the seat of many of the ordinary inflammations of the eye, that are so familiar to the laity, and which range in

c d

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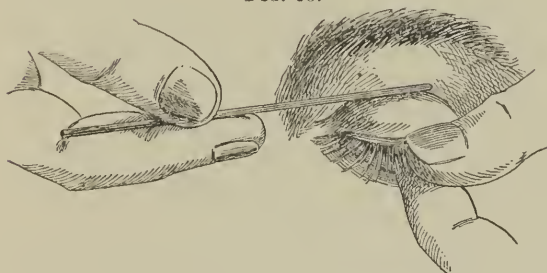
severity from a mere hyperæmia, or congestion, to what is known as "chronic granulated lids." When reference is made to what is commonly designated as a "sore eye," it is usually an inflammation of this membrane that is meant. The conjunctiva is continuous with the mucous membrane of the tear-passages which run into the nose. It is, therefore, frequently inflamed during the course of what is known as a "cold in the head." During an attack of jaundice, it is sometimes seen to be yellow, this being dependent upon a deposit of bile pigment in its tissues.

The conjunctiva is the principal lodging place of the various foreign bodies, such as dust, cinders, etc., that so frequently get into the eye and cause irritation. Some of these become embedded in the cornea, and have to be forcibly removed. The majority, however, are drifted along in the current of tears, as they flow from the external to the internal canthus, and there escape by means



of washing the eye, or other more or less natural processes. Occasionally the intruder remains fastened in the conjunctiva, where, as a rule, it will be found, after everting the lid, midway between the internal and the external canthus, just over the face of the

FIG. 16.

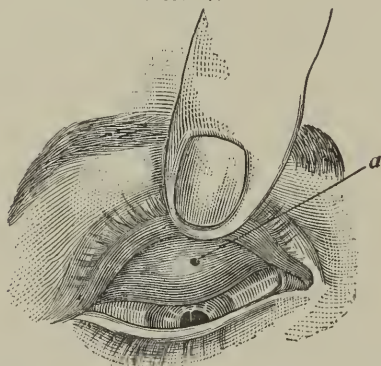


Exhibits the method of everting the upper lid.

tarsal cartilage. Eversion of the upper lid is performed as follows. The patient is asked to look down. The lashes of the upper lid are then grasped and pulled down. A pencil tip is placed between the lashes and eyebrows and a downward pressure made upon it. At the same time the lid is to be raised by means of the lashes.

These done properly, eversion occurs, when the foreign body may be seen and removed by a handkerchief, match, etc.

FIG. 17.



Shows the upper lid everted; *a* shows where foreign bodies can usually be located.

The inside surface of the upper lid is made up principally of a thin piece of cartilage lying underneath the conjunctiva. This is called the tarsal cartilage, and serves to keep the lid in shape. In the lid itself there is a ligament which originates at the bony ridge of the brow and is inserted in the tarsal cartilage, thus limiting the

extent to which the lid may drop. There is also a muscle called the levator palpebrarum, which originates near the optic foramen in the back part of the orbital cavity, and passes forward to be inserted into the cartilage; this muscle performs the function of raising the lid. There is another muscle, called the orbicularis palpebrarum. This muscle possesses circular fibres, and extends like an oblong wheel around the eye, under the skin of both the upper and the lower lids. It serves to close the lids, very much as a string or cord closes the opening in an old-fashioned pouch-purse. In addition to these structures, there are certain glands situated inside of the lid which are called the Meibomian glands. These empty themselves along the border of the lid, near the lashes. They are intended to lubricate the lid margins, and at the same time prevent a continual overflow of tears, by interposing a greasy edge, which acts, except in cases of extreme secretion, such as weeping, etc., in a manner that is sufficient

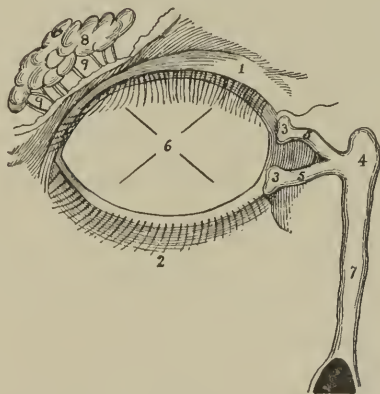
to retain any moisture within the palpebral fissure.

The lower lid resembles the upper in all essential particulars. The tarsal cartilage, however, is much smaller and of different shape. The muscle corresponding to the levator is much reduced in size, having little or no function to perform.

The lachrymal apparatus constitutes that series of anatomical elements which manufacture the tears and drain them into the nose. Among other things, it consists of a gland, known as the lachrymal gland, situated in the upper and outer part of the orbit, and which, as a rule, produces the tears in ordinary quantities. Under the influence of excessive emotion, foreign bodies, etc., these are secreted in large quantities. By means of little ducts which emerge from the side of the gland, the tears are conducted from the gland and pass over the surface of the eye, thus serving to keep it constantly moistened, and allowing the lids to move without irrita-

tion over its delicate coverings. In this way the tears flow from the external to the internal canthus, and are there drained into what are called the puncta; these consisting

FIG. 18.



Represents the lachrymal apparatus. The skin of the lids has been removed. 1 and 2, upper and lower lids; 3, 3, lachrymal points; 4, lachrymal sac; 5, 5, lachrymal canals; 6, palpebral fissure; 7, nasal duct; 8, lachrymal gland; 9, 9, lachrymal ducts.

of two little holes that are situated at the apex of a slight elevation, on both upper and lower lid, at the inner angle of the eye. These orifices or openings lead into two canals, one of which is intended for the

upper and the other for the lower lid. As they pass in the direction of the nose they converge toward each other, and empty into a space at the upper part of the nose, which is called the lachrymal sac. This sac, in its turn, merges into the nasal duct. The whole secretory and drainage system is lined with mucous membrane. Thus the tears, from their origin to their destination, pursue the following course: from the lachrymal gland to the lachrymal ducts, to the surface of the eye, to the puncta, to the canaliculi, or lachrymal canals, to the lachrymal sac, and to the nasal duct.

## CHAPTER II.

### LIGHT, LENSES, REFRACTION, AND ITS OCULAR ERRORS.

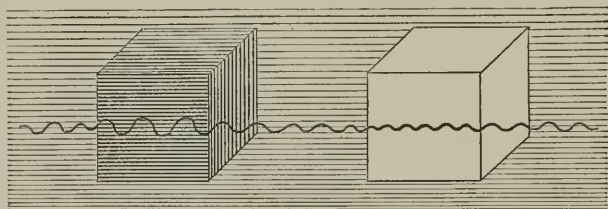
A RAY of light travels in waves or undulations, at the rate of about one hundred and ninety-two thousand miles in a second. Were no obstructions presented, it would proceed indefinitely into space. Such obstructions are either transparent, reflective, or opaque. At present only the first of these will be considered.

Transparent obstructions to light rays are either of similar, greater, or lesser density to the media from which such rays come. If the obstruction is of similar density, the waves of light, called rays, pass through the presenting substances in a straight line, or rather the undulations of light are not bent from their course or changed in their size.

If the presenting substance is of greater density than the medium from which the

light comes, the forcing of the rays through the obstruction is labored and slower, and hence the waves become coarser and more pronounced. (See Fig. 19, first obstruction.)

FIG. 19.



Illustrates the passage of a ray of light through media of different densities. (Oliver.)

tion.) If the presenting substance is of lesser density than the medium from which the light comes, the rays proceed through the obstruction with increasing facility and speed, and hence the waves become more delicate and less pronounced. (See Fig. 19, second obstruction.)

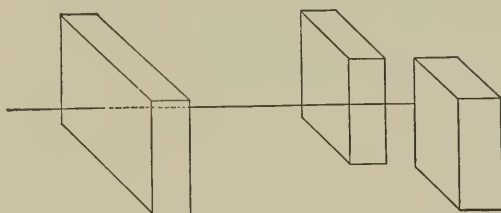
As the eye with its refracting contents is of greater density than the surrounding air and light, it is with the first of these propo-



sitions that we have to do in considering this subject.

If rays of light strike a denser medium in a perfectly straight direction, they pass directly through such medium without deviation from a straight line, as shown in Fig. 20.

FIG. 20.



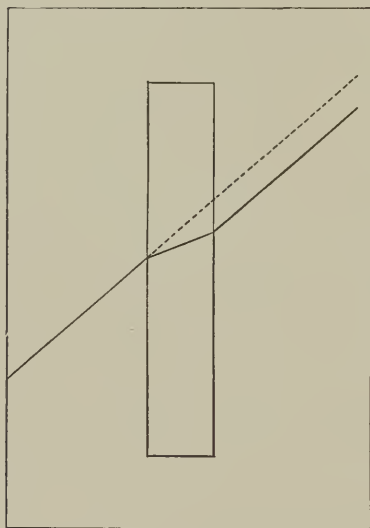
Shows the passage of a right-angled ray through a medium of increased density. (Oliver.)

If the rays strike such an obstruction in any but a perfectly vertical or horizontal position, such rays are bent or refracted, as it is called, as shown in Fig. 21.

If the surface of the receiving object be in the slightest degree deviated from a perfect level, either from its natural shape or

from being placed in a tilted position, the rays will also be bent or refracted.

FIG. 21.

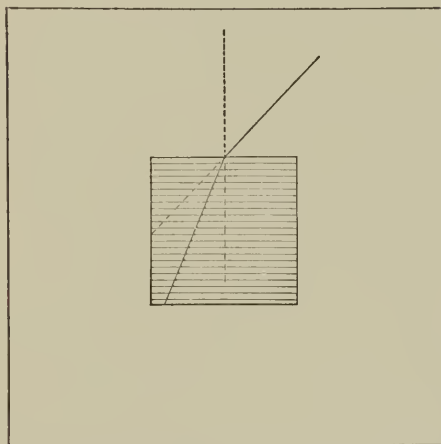


Shows the passage of an oblique ray of light through a medium of greater density. It also illustrates how the ray is deflected from its course.

If rays of light strike a substance of greater density in anything but a vertical or a horizontal direction, they are bent or

refracted toward the perpendicular of the obstructing substance. (See Fig. 22.)

FIG. 22.



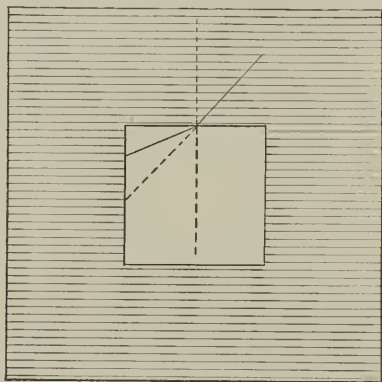
Shows the refraction of a ray passing from a rare into a dense medium.  
(Oliver.)

If rays of light strike a substance of lesser density in any other than a vertical or a horizontal direction, they are bent or refracted away from the perpendicular of the obstructing substance. (See Fig. 23.)

Let it be remembered that rays will always be bent or refracted toward the thickest por-

tion of a lens, be it convex or concave spherical, convex or concave cylindrical, or prismatic.

FIG. 23.

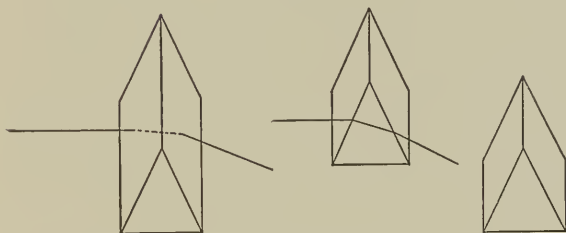


Shows the refraction of a ray passing from a dense into a rare medium.  
(Oliver.)

A prism, as applied to optics, is a transparent, wedge-shaped medium bounded by two surfaces that are inclined to each other. The point where these two sides meet is called the apex, and the point of their greatest separation, the base. A prismatic lens is therefore shaped as just described, and rays of light that enter one of its

principal sides must be bent or refracted toward its base, or perpendicularity. (See Fig. 24.)

FIG. 24.

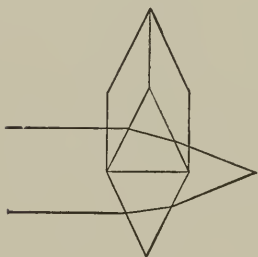


Shows the passage of a ray through a prism. (Oliver.)

All lenses are simply a natural evolution from a plurality of prisms that are joined together. Take, for instance, two prisms placed together base to base, and we have the first step in the evolution of a double-convex lens. Rays of light passing through such a combination pursue the same law or course as if each prism stood alone. Such rays enter the lens, bend toward the base, and pass out, converging as they emerge. As the two prisms lie base to base, and the two sets of rays pursue the same law, the

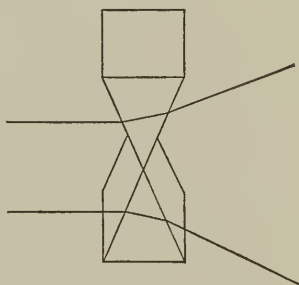
rays proceeding from the upper prism passing downward and those from the lower prism upward, they inevitably meet at a certain fixed point that is parallel with the bases of the two prisms. This point is called the focus. It is a point that is determined in all cases by the strength or refractive power of the lens. (See Fig. 25.)

FIG. 25.



Shows the passage of parallel rays through two prisms that are placed base to base, forming a focus. (Oliver.)

FIG. 26.



Shows the passage of two parallel rays through two prisms that are placed apex to apex, producing a divergence. (Oliver.)

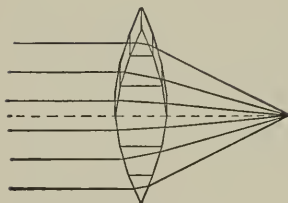
Take the opposite condition, viz., two prisms set apex to apex, and the first step in the evolution of a double concave lens

is obtained. Rays of light entering such a combination are amenable to the same laws that govern the previous case, but, the bases in this case being exactly reversed in their position, it will be seen that such rays must be separated, dispersed, or diverged. (See Fig. 26.) The same law which governs the direction of rays in these two instances obtains when a number of prisms are placed together in graduated order to resemble a double convex spherical lens. Each prism refracts the entering rays towards its base, and all the rays come together at the proper point or focus. (See Fig. 27.)

When a series of prisms is placed in apposition to one another so as to resemble a double concave spherical lens, the rays are dispersed according to the same law. (See Fig. 28.)

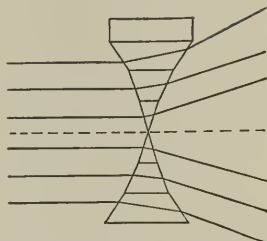
Such instances are only sections of lenses, and if it is wished to evolve a complete and perfect convex or concave spherical lens, such sections must be put together and joined as

FIG. 27.



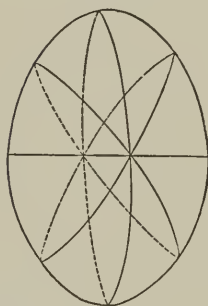
Shows the passage of six parallel rays through six truncated prisms with their apices pointing outward, forming a compound focus. (Oliver.)

FIG. 28.



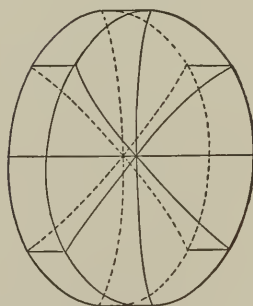
Shows the passage of six parallel rays through six truncated prisms with their bases pointing outward, producing a divergence. (Oliver.)

FIG. 29.



Shows a biconvex spherical lens. (Oliver.)

FIG. 30.



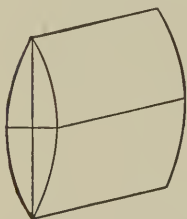
Shows a biconcave spherical lens. (Oliver.)



indicated in the drawings, and the surfaces smoothed and accurately graduated. As a result, a convex or a concave spherical lens capable of focussing or dispersing rays is obtained. (See Figs. 29 and 30.)

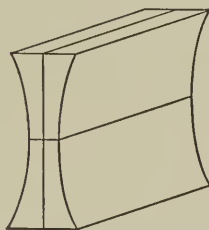
A cylindrically shaped lens is evolved in the same manner, except that the completed

FIG. 31.



Shows a biconvex cylindrical lens. (Oliver.)

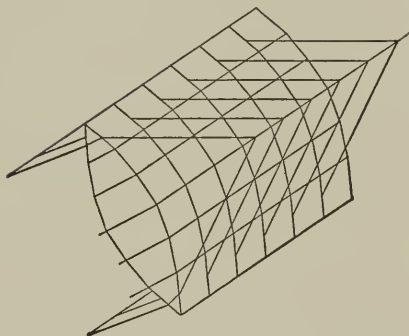
FIG. 32.



Shows a biconcave cylindrical lens. (Oliver.)

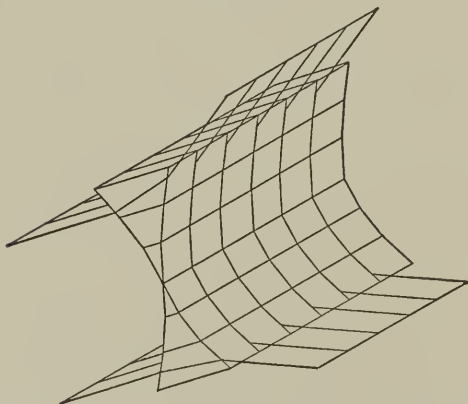
combination is joined together laterally, the prisms are not united around a circle, as it were, but are placed side by side, so that the focus, which in a convex *spherical* lens is punctated, becomes elongated into a line (see Fig. 33) in a convex *cylindrical* lens, while the dispersion of rays, which in a con-

FIG. 33.



Exhibits the formation of a focal line from two parallel planes by a combination of truncated prisms forming a biconvex cylindrical lens. (Oliver.)

FIG. 34.



Exhibits the dispersion of two parallel planes by a combination of truncated prisms forming a biconcave cylindrical lens. (Oliver.)

cave *spherical* lens is circular, becomes also elongated into a line (see Fig. 34) in a concave *cylindrical* lens.

These points of dissimilarity inevitably lead to the conclusion that while, with convex and concave spherical lenses, the rays becoming converged or diverged are the same, no matter at what axis the lens is held; with convex or concave cylindrical lenses, the rays, becoming either converged or diverged, being linear and not punctated, must move with the rotation of the lens upon its axis.

This is in fact the very element that renders such lenses useful in the correction of astigmatism, where the cylindrical shape of the cornea is neutralized by the cylindrical shape of the lens, when set at the proper axis in a spectacle frame.

Having now given a practical, but still sufficiently accurate idea of the anatomy and physiology of the eye, the principles of light and refraction, and also some ideas concern-

ing the evolution of lenses and their functions, attention should be turned to those errors of refraction which are incident to the human eye.

#### HYPERMETROPIA.

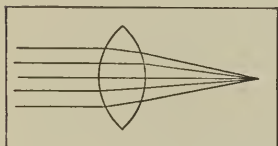
To recapitulate: Light is said to be refracted when its rays passing from one medium to another become bent or refracted in different directions in correspondence with the nature and relative position of the second medium.

If light passes through a convex spherical glass, the rays are refracted in such a manner as to converge, to come together, or to focus at a point that corresponds with the strength of the glass. Therefore, a three-inch convex lens focuses light at a distance of three inches from the lens, a two-inch convex lens at two inches, etc. (See Fig. 35.)

If the surface of the glass is concave and spherical, rays of light as they pass through it are spread or diverged. (See Fig. 36.)

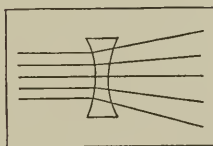
It can be seen that the eye, being a convex medium, converges rays as they pass through it, and brings them to a focus on

FIG. 35.



Shows the focussing of parallel rays of light that have passed through a biconvex lens.

FIG. 36.



Shows the divergence of parallel rays of light that have passed through a biconcave lens.

the posterior or receiving wall, known as the retina.

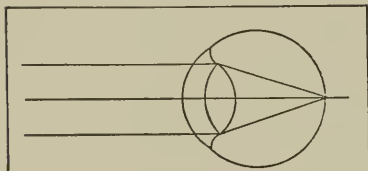
The principle of refraction is intimately involved in the adjustment of glasses, as it is upon this principle that either convex or concave glasses are prescribed. If it is desirable to bring rays to a focus sooner than occurs naturally in the eye under consideration, a convex glass is used. This is done for the reason that such a lens converges rays. If, on the contrary, it is desirable to throw the rays farther back in the eye upon

account of an elongated eyeball, a concave glass is used. This is done because such a lens diverges or spreads rays.

Refraction, as referring to the eye, means the bending of rays proceeding from a distant object to focus upon the retina. Normal refraction is where this act is accurately performed, and abnormal refraction is where such rays are not naturally so focussed.

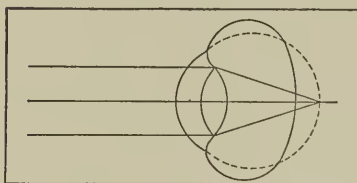
The normal eye is so constructed, as to its length from its anterior to its posterior extremity, that rays proceeding from a distant object are focussed exactly upon the retina without any voluntary or involuntary effort. Any deviation from such an antero-posterior diameter from the cornea to the retina constitutes one of the forms of erroneous refraction, and will, consequently, be followed by abnormal conditions of vision. If the eye is of exactly the proper length, rays proceeding from an object will focus exactly on the retina. If the eyeball is too short, rays will focus (*theoretically*)

FIG. 37.



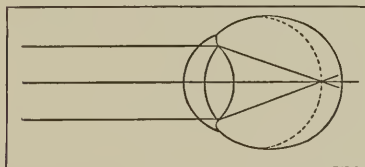
Illustrates the emmetropic eye, and shows how rays focus accurately upon the retina.

FIG. 38.



Illustrates the hypermetropic eye, and shows how rays focus (theoretically) behind the retina.

FIG. 39.



Illustrates the myopic eye, and shows how rays focus in front of the retina.

behind the retina, and the impression received upon the retina will be blurred and diffused. If the eyeball is too long, rays will focus in front of the retina, and then crossing one another and diverging will reach the retina in a blurred or diffused condition. The proper point of focussing is fixed and unvarying. If the retina is not there to meet the rays, vision is said to be impaired.

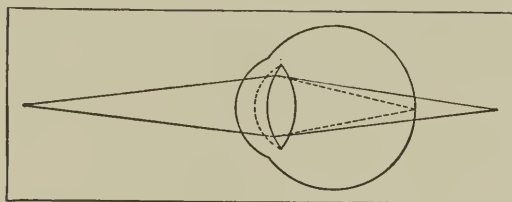
Normal refraction is called emmetropia. Where the eyeball is too short, or where there is too little focussing material, the condition is termed hypermetropia. Where the eyeball is too long, or where there is too much focussing material, myopia is said to be present.

In hypermetropia, then, rays proceeding from an object are focussed, at least theoretically, behind the retina. The retinal plane being advanced farther forward than the proper focal point renders a real focus of the rays impossible, as they cannot pierce



an opaque wall. In consequence, the focal point occupies an imaginary place behind the retina. The result of this error in refraction is to produce a blurred and indis-

FIG. 40.



Represents a hypermetropic eye. Here the rays focus behind the retina, but the ciliary muscle, or muscle of accommodation, forces the lens into a condition of increased convexity, causing the rays to become focussed upon the retina.

tinct retinal image of the object upon which gaze is concentrated. At least, in the great majority of instances, such would be the case were it not for the intervention of the ciliary muscle and crystalline lens, which come to the aid of the eye and enable it to focus distinctly. Some pages back, it has been shown what constitutes this wonderful physiological process of accommodation. It

will be remembered that it is accomplished by the exertion of the ciliary muscle, acting upon the lens and forcing it into a condition of increased convexity. So here, in the hypermetropic eye, an involuntary effort of the ciliary muscle is produced and maintained. In such eyes, however, while such an exertion, when retained within the bounds of physiological limit, is non-injurious, where an excessive and constant effort is effected it becomes a pathological and abnormal feature. This effort corresponds with the amount of hypermetropia that is involved in each particular individual. If the eyeball is shortened only to a slight extent, the amount of increased convexity maintained by the lens is correspondingly slight, while in cases of great shortening the lens becomes extremely convex. It therefore becomes essential, if normal sight is produced, to lengthen the eyeball, as it were, and to force the rays to focus upon the retina. As the eyeball itself cannot be lengthened,

it becomes necessary that the antero-posterior diameter of the lens (or part through which the image rays pass) should become adequately longer, or more convex, which practically amounts to the same thing. In such cases this, the so-called accommodative effort, takes place not only when the eye is used for close work, but at all times, except during the hours of sleep. The result of this perpetual over-exertion is rebellion, just as it would be if any other muscle, nerve, or function in the body were abused. For example, were a man to labor continuously twenty hours in the twenty-four, he would soon reach a point where human endurance would cry out against the folly. If strong and healthy, he might endure it several years, but if sickly and debilitated, he would sooner reach the limit of his powers. This is exactly the condition in hypermetropia when the ciliary muscle becomes perpetually overtaxed. No complaint may be made for

years, especially if the individual happens to be strong and robust, or if the person be young, with a soft and pliable lens that is easily shaped to the will of the ciliary muscle. Sooner or later, however, the accommodative apparatus will protest. This is more liable to occur after some long and debilitating sickness, especially if the patients use their eyes for near-work whilst lying in bed during convalescence, before strength has become re-established. Again, it may occur during the course of some slow and exhausting chronic disease. Moreover, it may follow excessive or imprudent use of the eyes in an otherwise healthy individual. Whatever the cause may be, certain symptoms, which are classed under the one term *asthenopia*, make their appearance. By this is meant a tired and weary feeling of the eyes and head; an inability to continue long at any close occupation; headaches, especially in the front and back part of the head; a heaviness and apparent roughness of the

lids; overpowering sense of sleepiness early in the evening, soon after artificial lights are used; various forms of neuralgia, etc.

What is to be done to relieve such cases can be readily answered by any one who comprehends the significance of the symptoms. It has been shown that they indicate a continual and abnormal taxation of the strength of the ciliary muscle in order to add to the convexity of the lens. To relieve this taxation, it is merely necessary, then, to place a lens of sufficient convexity in front of the eye to compensate for the degree of refractive error. By the use of certain tests, the physician ascertains the amount of antero-posterior shortening existing in a given eye. He then prescribes a lens that is sufficiently convex to produce more quickly a suitable convergence of entering rays, and thus compensate for such shortening. In this way a proper length of light ray is established and the strain is taken off from the ciliary muscle and crystalline lens.

## MYOPIA.

This term is significant of the opposite refractive condition from hypermetropia. As has already been mentioned, myopia signifies a lengthened axis of the eyeball from the cornea to the retina, or, in other words, too much intraocular focussing material, so that rays from distant objects, instead of forming upon the retina a clear and distinct focus, fall in front of the retina, cross in the interior of the eye, and reach the retina in a diffused or blurred condition. The result is a greater or less degree of indistinct vision, the amount of diminution of sight being in direct proportion to the degree of abnormal lengthening of the eyeball. As a rule, the condition is not accompanied by any marked asthenopic symptoms.

Myopia is sometimes expressed by the laity as "near-sightedness." By some "long-sightedness" is supposed to be a term of contradistinction, but this is clearly in-

correct, as it frequently happens that many hypermetropic people possess poor distant vision. "Long-sightedness" might be, and has been, appropriately used to express presbyopia, or the poor vision of old age, when it becomes necessary to hold print at a long distance in order to read it, but, unfortunately, the application of the term has become mixed or diverted to express hypermetropia.

The last chapter in this book will treat largely of myopia, its extensive existence, causes and relation to school life, etc.; so that this portion of the subject will be reserved until then.

It has been said that a myopic eye is an elongated eye, or one with too much focusing power, and that the rays which proceed from an object are focussed in front of the retina, and hence reach this membrane in a diffused condition. In hypermetropia nature compels an increased convexity of the crystalline lens, by taxing the power of the ciliary

muscle. In myopia she allows a relaxation of the ciliary muscle, which, upon account of the elasticity of the lenticular capsule, induces as flat a condition of the lens as possible, in order to throw the focus of rays farther back, and produce clear vision. In other words, the accommodative function is reduced to a minimum, thus accounting for the ordinary lack of asthenopic symptoms in such cases, which, when found, are usually produced by a strain of the internal recti muscles, from inducing convergence of the two eyeballs, which, owing to their elongated shape, is difficult to accomplish.

In very mild cases a flattening of the lens to its full extent may assist in mitigating an existing myopia, but in others its utility is reduced to a minimum. Theoretically, the eye must be still further flattened, or at least something must be done (which amounts to the same thing) to throw the rays proceeding from an object farther back, so that the focus will just touch the



retina and produce clear vision. This can be accomplished by a concave glass. After first ascertaining, by certain tests, the degree of near-sightedness, a corresponding strength of concave glass should be placed in front of the eye, thus focussing rays upon the retina, and restoring vision to a normal standard.

#### PRESBYOPIA.

Presbyopia is one of the ocular evidences of advancing years. In youth the muscles, nerves, joints, and other tissues and constituents of the body are strong and pliable, with almost unlimited power and boundless capability; but as youth is succeeded by middle life, and this by old age, these functions become more and more impaired. It is thus found that the possibilities of early life become the impossibilities of maturity and old age. The eye is no exception to this rule. Here it is principally in the accommodative apparatus that such increasing feebleness is exemplified. In the early

years of life the ciliary muscle, ciliary ligament, lenticular capsule, and crystalline lens respond with alacrity to the slightest need or wish of the individual, but, as the meridian of life is passed (which occurs at about the fortieth year), the ciliary muscle and ciliary ligament become less active, the capsule of the crystalline lens becomes less elastic, and the crystalline lens itself becomes harder, more compact, and less capable of changing its shape to one of greater convexity when small and near objects are brought into view. In other words, active accommodation becomes more and more difficult, until the individual is obliged to employ stronger illumination for reading, writing, etc., and must hold the object at an increased distance from the eye. The man who has always possessed strong eyes finds that his reading light is no longer as strong as it formerly was, that the print of papers, books, etc., is of inferior quality, that he is compelled to hold the book at some dis-

tance in order to see more or less distinctly, and that his eyes feel tired and weary after use. He worries along in this way, either through ignorance as to the cause, or upon account of an unwillingness to acknowledge the encroachments of age, until he secures a pair of properly adjusted glasses. Peace is then restored, for a period at least. As the presbyopic condition advances, increasingly stronger glasses become necessary to meet the emergencies of the case. As the female sex grows old earlier than the male, so presbyopia, as one of the attributes of age, is usually manifested in women about two years earlier than in men. Owing, however, to an unfortunate pride in personal appearance, and an indisposition to acknowledge age, women generally refuse to wear glasses until their use is rendered absolutely necessary by a sheer inability to make use of the eyes.

In testing an eye for presbyopia, a very small and distinct type is used. This is

known as No. 1 Snellen type, and should be seen by the normal eye at a point at

FIG. 41.

No. 1.

THE eye is a delicate structure, exceedingly sensitive, yet performing an immense amount of labor without any appreciable fatigue, and adapting itself to various distances and to various intensities of light, so as to astonish even the most casual observer. Thus, we can read by the light of the moon, by twilight, by the light from a small taper, etc., and these lights are by no means to be compared with the light emanating from the sun. The light from the sun is estimated to be 300,000 times more brilliant than that from the moon; or equal to that given out by 5,000 wax candles of moderate size, supposed to be placed at

Shows what is known as No. 1 test-type.

least as near to the eye as ten inches. The nearest distance at which this type can be seen is called the "near-point of vision," and the farthest point at which it can be seen is termed the "far-point of vision." The "near-point of vision" in youth is much nearer than ten inches, but presbyopia is not said to be present until the "near-point" recedes farther than ten inches from the eye. Presbyopia is then a recession of the near-point of vision that accompanies old age; and the object of fitting a glass is to bring the near-point of vision from an abnormal distance, or perhaps an inability to see No. 1 Snellen type at all, back to ten

inches. The weakest glass that accomplishes this is usually the one chosen, as, the weaker the glass, the less restricted will be the far-point of vision, and, consequently, the wider will be the range of vision. This is of importance to most people, who find it inconvenient to take off a glass fitted for presbyopia, in order to see a few feet away.

After securing a pair of glasses for presbyopia, patients often inquire as to the length of time that the lenses will remain satisfactory. This is something that cannot be satisfactorily answered, for, while a glass usually answers the purpose for perhaps two years, it sometimes happens that it may last much longer, or, on the contrary, it may require alteration in a few months. In a large measure each patient should be his own guide. As a rule, a glass may be safely worn as long as it produces ease and comfort, but should be discarded when reverse conditions obtain. After discussing the principle underlying the correction of hyper-

metropia and myopia, it seems almost unnecessary to suggest the kind of glass that is required for neutralizing presbyopia. In presbyopia there is a flattening of the lens and an inability to bring it to a sufficient degree of convexity to easily discern print, etc. The logical remedy is clearly to increase the convexity of the crystalline lens by artificial means, thus restoring the power for near-work. This is done by placing in front of the eye a convex glass of such a degree of convexity as to bring back the near-point of vision to ten inches, and at the same time to allow as much elasticity to the range of accommodation as possible.

#### ASTIGMATISM.

Astigmatism is a word that is frequently heard upon the lips of people who, whilst knowing little or nothing about the condition, seem to think that it is a very distinguished and desirable disease.

Astigmatism is an error of refraction that

is largely dependent upon a more or less cylindrical curvature of the cornea, which should, as already explained, be practically spherical in outline. If an individual looks out through a spherically-shaped cornea, all portions of an object are seen with equal clearness and distinctness. If, on the contrary, the cornea is cylindrically shaped, objects must appear distorted or be seen with unequal clearness, thus producing various asthenopic symptoms that may cause almost unendurable suffering.

The reader has doubtless seen cylindrical mirrors, which, when looked at with the long axis of the reflector situated vertically, render the person looking at himself extremely long and thin. When, however, the long axis of the mirror is placed horizontally, a short and fat appearance of the observer is produced. This experiment will, in an exaggerated way, serve to illustrate the distortion of objects that is occasioned by a cylindrical lens when placed before

the eye. It also serves to illustrate the distorted appearance of objects when seen through a cylindrically-shaped cornea. This is often quite manifest to those who are unfamiliar with the subject, but who go to the physician with the voluntary remark that they can see the vertical lines in a brick wall clearly, but are unable to discern the horizontal, or vice versa, etc. etc.

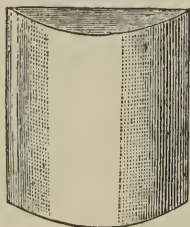
Astigmatism may appear in several varieties and be situated in any axis. For instance, it may be vertical ( $90^\circ$ ), or horizontal ( $0^\circ$  or  $180^\circ$ ), or at any intervening angle.

Ordinarily there are five varieties of astigmatism. The first and the second are known as simple astigmatism, where one meridian of the eye is either myopic or hypermetropic and the other meridian is emmetropic, or normal. The third is known as compound hypermetropic astigmatism, where two degrees of hypermetropia are situated at right angles to one another. The fourth



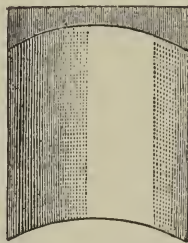
is known as compound myopic astigmatism, where two degrees of myopia exist at right angles to one another. The fifth is termed mixed astigmatism, because one meridian of the cornea is myopic and the other is hypermetropic.

FIG. 42.



Shows a convex cylindrical lens.

FIG. 43.



Shows the form of a concave cylindrical lens.

When the astigmatism is of a hypermetropic character, it generally indicates that there is a cylindrical corneal flattening. If it is of a myopic character, it ordinarily indicates that there is a cylindrical corneal elevation. The former variety is to be corrected by convex cylindrical lenses, and the

latter is to be corrected by concave cylindrical lenses, each set at their proper axis. For instance, in a case of simple hypermetropic astigmatism, a simple convex cylindrical lens must be used. For simple myopic astigmatism, a simple concave cylinder should be employed. For compound hypermetropic astigmatism, a glass that is ground spherically convex on one side and cylindrically convex on the other becomes necessary. For compound myopic astigmatism, a glass that is ground cylindrically concave on one side and spherically concave on the other is to be used. For mixed astigmatism, a glass that is ground convex cylindrically on one side and concave cylindrically on the other, the two axes set at right angles to each other, is the one that becomes necessary.

It must not be forgotten that astigmatism may coexist with presbyopia, and that its presence must be remembered in fitting a spherical glass for the latter condition. This can be done by combining the necessary

spherical lens with a proper cylindrical lens, the one being ground upon one side of the glass and the other upon the opposite side of the glass.

## CHAPTER III.

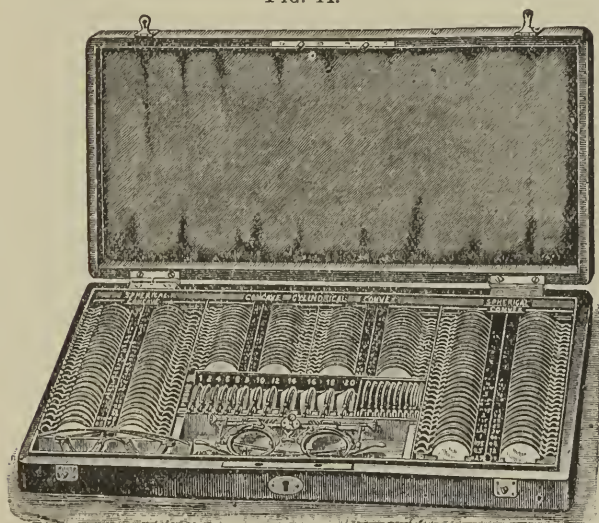
### TEST-TYPES, GLASSES, ETC.

A BRIEF description of the methods pursued by physicians in testing the eyes of patients may be of interest to the general reader.

Of the many methods to be pursued in studying ocular refraction, the principal one is accomplished by means of a series of test-types and a set of trial glasses. The latter contains a great variety of spherical and cylindrical lenses, both convex and concave in character, arranged according to strength or degree. There is also a pair of trial frames, so constructed that the lenses can be easily slipped into the frames and readily removed. These frames are graduated into degrees of a circle, thus enabling any prismatic or cylindrical glass to be turned to any desired axis. The test-types

are printed upon a card. These letters are of varying sizes, each size situated upon a

FIG. 44.

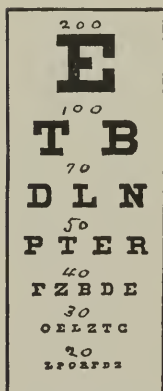


Shows a set of trial glasses.

corresponding line. According to optical and mathematical calculations, these letters must be seen by a normal eye at certain definite distances. For instance, the largest letter upon the miniature card here shown should, if the card was of natural and not

reduced size, be seen at two hundred feet. The next should be recognized at one hundred feet;

FIG. 45.



Exhibits a card of test-types (much diminished in size).

the next at seventy feet; and the others at fifty, forty, thirty, and twenty feet respectively. In this way it can be quickly ascertained whether vision is normal or not. As a rule, physicians make the line that should be seen at twenty feet their standard of visual measurement. To do this the patient must be placed twenty feet away from the test-types.

This rule is, however, purely arbitrary, as any other line might be used, only of course the position of the patient must be accordingly changed. For instance, if a thirty-foot line on a card is used, the patient should be seated thirty feet from the test-types, etc.

The question is often asked, why do

physicians so often use belladonna, or its active principle, atropine, in testing eyes? The answer may be briefly and sufficiently stated for the general reader, as follows:

FIG. 46.



Shows the actual size of the test-type which should be seen by the normal or emmetropic eye at twenty feet.

Owing to the excessive activity on the part of the ciliary muscle—especially in hypermetropia and astigmatism—the muscle sometimes develops a condition of greater or less irritability and spasm, which masks the *real refraction* of the eye. Belladonna has the power of paralyzing the ciliary muscle, thus doing away with the activity of the muscle during an examination, which allows the true refraction to be revealed. When this is done the eye can be accurately tested. It must be remembered that each eye must be tested separately, as the refraction of the two eyes may materially differ.

By means of the methods just indicated, as well as by other procedures (which could be appropriately mentioned only in a book designed for medical men), errors of refraction may be accurately estimated. Although it appears simple, and in reality is easy in many features, yet it may be said of this class of professional labor, that it is the most painstaking, the most difficult, and the most nerve-exhausting that falls within the province of any conscientious physician, and at the same time is the labor that is rewarded by the smallest compensation. There exists a time-honored idea that any one can fit glasses, and that it is foolish prodigality to pay a fee for securing an accurate correction of refraction by lenses. Upon the contrary, such work requires eminent skill, patience and knowledge, and it is to be regretted that any government permits such practices in department stores, fairs, or, in short, in any place outside of a physician's consulting room.



The query is frequently propounded, shall I wear eye-glasses or spectacles? The answer depends on the nature of the glass required and the shape of the facial features. On general principles it is always better to wear spectacles, especially if the glass is strong or if it is a cylinder, as such lenses should be accurately placed before the eye, with the centre of the lens opposite the centre of the pupil. If the glass is strong and the two centres do not correspond, the patient fails to acquire the presumed strength of the glass, and hence suffers from a prismatic effect, which by acting improperly on one or more of the extra-ocular muscles may produce injurious consequences. Again, if the lens is a cylinder and is designed to be placed at a certain axis, it should always remain at this axis when on the face. This is best accomplished by spectacles, for the reason that eye-glasses are liable to change of position and consequent misplacement of the cylinder axis. Exceptions are, however,

not infrequently made to meet the emergencies of special cases. A patient possessed of a nose that is shaped for the support of eye-glasses may be able to retain them in accurate position. If it is necessary that glasses be frequently removed, or if the question of personal appearance is to play an important rôle in the consideration of the case, eye-glasses may be permitted, though even then they are not desirable. If, however, the nose is flat, the eyes widely separated, and the glass is strong or cylindrical, spectacles must be unqualifiedly advised.

Rimless or skeleton glasses, although popular, possess several disadvantages. They are supplied with four rivets that pass through the glasses. To some eyes these glasses are not only an annoyance, on account of the rivets, but are very liable to breakage. In addition to this latter sometimes exasperating and expensive objection, such glasses will inevitably become loose-

jointed and the lenses at once assume different angles. If skeleton glasses are worn, they should be ground dull at the edges, so as to prevent the annoying effect of prismatic colors. They should also be frequently repaired, in order that they may be kept in proper condition.

FIG. 47.



Shows a pair of bi-focal glasses. The upper portion is arranged for looking at a distance, and the lower for close-work, such as reading, writing, etc.

Occasionally there is a necessity for two sets of glasses, one to be used for distance and the other for reading; under these circumstances, the example of Benjamin Franklin may be followed, in which he used split or bi-focal glasses, where two lenses (the upper for distance and the

lower for reading) are contained in a single frame. This arrangement is very convenient, though difficult to become accustomed to; but when this has once been accomplished, they are much appreciated, as they enable the patient to use one pair of glasses for all purposes.

Sometimes it is necessary to wear even three pairs of glasses. Especially is this so with musicians, artists, etc., who are compelled to use their eyes accurately at some particular distance, such as a music-rack, an easel, etc.

Great stress is sometimes laid on the purchasing and wearing of what are known as "pebble" glasses. It may be briefly said that the ordinary glass sold by a competent optician is sufficiently perfect. In fact, such glass is usually purchased when pebble glasses are paid for, as it requires both skill and experimentation to discriminate between the two varieties.

The inquiry is often made as to whether

it is advisable to wear colored glasses, and, if so, what kind should be worn. Colored glasses should not be employed unless there is a specific reason for their use, such as a diseased eye, or temporary exposure to bright and trying lights. It is therefore not advisable to accustom the eye to their use, as eventually the wearing of them becomes almost a necessity. When worn, however, a medium shade of smoke glass, of good quality, is the best form to use.

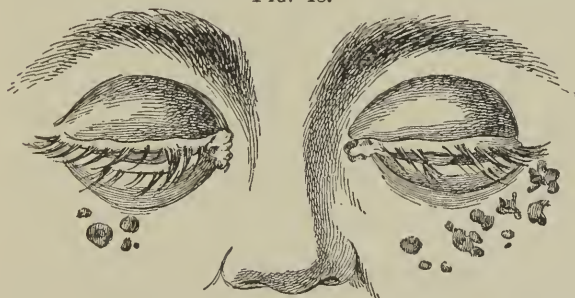
## CHAPTER IV.

### THE GENERAL CARE OF THE EYE.

THE care of the eye commences at birth and continues uninterrupted until death. A large proportion of the inmates of blind asylums are sent there upon account of an inflammation that occurs about three days after birth. This form of ocular inflammation is known as "ophthalmia neonatorum," or the "conjunctivitis of the new-born." It is an inflammation of the conjunctiva of a peculiarly severe type, and often results in impairment of vision. Intelligent physicians should be retained at such important occasions, and nurses and parents should strictly follow their advice, for, if such counsel be in accordance with modern science, the percentage of blindness among new-born babes will thereby be greatly reduced. Even if such an unfortunate disease does not exist,

nurses and parents should exercise great care of the eyes at such times by keeping them clean and by frequently bathing them in warm water. Occasionally, if the lashes seem scaly, the greasing of the edges of the lids with a little vaseline will prove beneficial.

FIG. 48.



Shows the external appearance of ophthalmia neonatorum, or conjunctivitis of the new-born.

Eyes of young infants should be protected from glaring lights, and it is advisable that their room, while warm, well-ventilated, and cheerful, should not be so situated as to expose the eyes to the direct rays of the sun. The value of this suggestion is not confined to indoor care, for the delicate retina may

easily be injured, by the not unusual practice of allowing a child to lie in its carriage and gaze directly at the sun, without being protected by an umbrella, a veil, etc.

The attention of an infant should not be directed to objects held close to its face. The reason for this is that marked and frequent convergence of the eyes may be liable to produce strabismus or cross-eyes. As the child grows older, this precaution should not be forgotten, remembering, further, the possibility of producing myopia under the pressure of extreme convergence and close application. Children should therefore be discouraged from playing with small objects, toys, etc., and from poring over story and picture books. They should be encouraged in out-door amusement and sports, where the eyes during these developing periods of life can have wide range and free scope, and where the general physical health and development may take precedence over ocular and intellectual labor.



Ordinarily, there is a great indisposition to wear glasses ; a prejudice that is born and fostered of ignorance. Few misapprehensions are more foolish, for the proper adjustment of lenses to the improperly refracting eye is one of the greatest boons to humanity. Where glasses are needed, they should be worn, and a failure to do so means deterioration of ocular health and functions, and usually produces much unnecessary suffering to the individual.

After what has been said, it is hardly necessary to further indicate the necessity for glasses for the correction of the different errors of refraction, nor to urge the necessity of consulting a physician upon the approach of obstinate headaches or other asthenopic symptoms, or the discovery of a lack of vision.

To those who wear glasses, a few words as to their proper use may not be inappropriate. In the first place, if eye-glasses are worn, they should not be folded together, as,

by so doing, they soon become misshapen, scratched, or dulled. They should either be hung unfolded on a hook on the outside of the dress, or carried flat in a case, thus keeping their shape and lustre. For the same reason, glasses should not be laid carelessly upon tables, stands, etc. They should be kept clean. This may be done by rubbing them gently with a clean and soft cloth, it being unnecessary (in accordance with popular fancy) to employ chamois-skin.

Glasses should not be worn indefinitely. They should be changed or repaired as they become worn, nicked, cracked, and out of shape. All things considered, a gold frame is the best and cheapest that can be purchased. Gold frames are pliable, and yet hold their shape well. They are also durable, and will usually outwear several steel frames. They do not hurt the ears or nose, and are free from rust. These advantages, together with the fact that they look

as well as glasses can, certainly recommend them for use.

If colored glasses are to be used, a good quality of material should be selected. To do this, it is best to patronize a reputable optician and pay him an adequate price, instead of purchasing them of a street vender or from other irresponsible parties. There is much difference in colored glasses. Some are clear, while others are full of flaws and imperfections. Some are smoothly ground, whilst others have rough surfaces. Some have no refractive power, while others have one that is annoying and, at times, even injurious.

An important point in obtaining glasses is not only to have the lenses properly prescribed by a physician, but also to see that the frames are correctly adjusted by a competent optician. This is necessary, as there are so many varieties of facial features which require genuine skill and judgment to harmonize with lenses and frames, that

the proper fitting of spectacles and glasses requires the combined skill of both the physician and the optician, and the one will be sadly crippled, without the intelligent aid and co-operation of the other.

One of the most important questions pertinent to this chapter is that of light. This may seem a matter that can be easily managed, but he who entertains such a sentiment has but little knowledge of the unfortunate circumstances under which a large proportion of the human race work. To say nothing of the improper lighting of schools, which will be referred to in the last chapter, it will only be necessary to remind the optimist of the immense army of people who work at home—in inside court-rooms, by insufficient daylight by day, and by wholly inadequate light at night. Again, there is another class who continue to read after twilight has arrived, and when illumination has become feeble. Again, there are others who read or work by one or two gas-

jets in a chandelier situated at a remote distance from the page or cloth. Others work perpetually in banks, office buildings, etc., where good daylight never penetrates, and still others, who not only read on trains by daylight, and are subjected to the jolting of the cars, producing a strain upon the ciliary muscle, which continually establishes new accommodative adjustments, but who foolishly read by the dim and insufficient overhead light that is usually furnished in the cars of most of our railways. If one will or must read on the train at night, he should endeavor to select a road amply lighted by electricity in general and by little incandescent lights in each section, as may be found in the lines operated by the Chicago, Milwaukee & St. Paul Railroad.

The best light is the diffuse natural light of day, and the best artificial light is that which most nearly approaches daylight. Even daylight may be abused, or, at least, it may be improperly used, for care must be

taken that it reaches the near object gazed at in the right manner. For obvious reasons, a desk should not be situated so that the light comes directly into the face of the worker; neither should the light come from behind the worker's back, as his body will shade the page; nor from the right side, as his hand will do the same thing. The light should come from the left side, so that it may be ample and yet not shine directly in the face, and so that it may strike the paper (during the act of writing) without obstruction from the hand. In reading without a desk, the individual should sit erect, with the back held reasonably up, with the light coming from the left side, as in this position the best and most unobstructed illumination is obtained. These rules are equally necessary and applicable when using the eyes by means of artificial illumination.

Artificial light should be profuse, white, and steady. Kerosene, gas, and electricity are the principal sources of illumination

used at present, and it may be said that they are all good, and perform admirable service, if properly controlled. They should be shaded by globes, colored white on the inside, and preferably tinted green on the outside. They should be placed in such a position that they are brought sufficiently near the individual to afford ample illumination.

The chief objection to the incandescent light consists in an annoying and trying shadow (emanating from the heated wire) that is thrown upon the page beneath. This, however, can fortunately be remedied by the use of translucent globes.

Much of the print thrown upon the market is extremely small, badly impressed, and hence very injurious to the eyes. This is usually found to be the case in sensational papers and novels that are widely read; consequently, the evil effects are felt by a large proportion of the population of the reading world. Newspapers especially are

poorly printed, and, as no other publications are so freely read, the effect upon the eyes may be pernicious.

In choosing books too much care cannot be bestowed upon the selection of large, clear type, and, as almost everything worth reading can be found well printed, cheap and injurious publications should be eschewed.

The paper from which we read, or upon which we write, is also of importance. A dull-surfaced, slightly tinted paper is preferable to white, and the best tints are delicate shades of gray, neutral tint, or bluish-green.

A prolific source of eye-strain is reading whilst the body is resting in a recumbent position. Especially is this so during convalescence following a severe illness, when the temptation is strong, but the general and ocular systems are weak and unable to stand even a limited amount of work. Even in health, owing to the fact that under such circumstances it is practically impossible to hold a book in a favorable



position where the muscles of the eye will not undergo excessive strain in accommodating themselves to the abnormal posture, such a practice is injurious.

Eyes are not infrequently injured by exertions which would never be demanded of any other organ of the body, they evidently being regarded as untiring and exhaustless. This is especially true after a physician has been consulted and glasses procured. Patients appear to consider that after this has been accomplished their ocular functions should have the strength and endurance of steel. It must never be forgotten that the eye is a delicate and exceedingly complex organ, and that, while it is long-suffering, its endurance has a limit, which, if pressed too far, will rebel and precipitate the most direful consequences. Therefore, the eye should be treated with judgment and forbearance, and not be made to perform more than a fair day's work. Such a resolution would suggest occasionally resting the eyes during

working hours by looking from time to time at distant objects through a window, or by changing occupations as often as may be,—*i.e.*, from reading to writing, and from writing to some other form of employment. Moreover, it must not be expected that after using the eyes all day in an office or a store they can be used the major part of the evening at home. Yet many people persist in these practices from year to year, and then wonder what is the matter with their eyes, and, if they consult a physician and procure lenses, they delight in telling him that they have paid him a consulting fee for nothing, and that his glasses are worthless.

It should always be borne in mind to hold the book, page, sewing, etc., as far away from the eye as is compatible with good vision, as the farther away such work is held, the less the ciliary muscle is taxed for accommodation, and the less are the internal recti muscles used for convergence. The natural tendency is averse to this rule, but, if faith-

fully remembered, it will soon become second-nature, and the greatest amount of eye-work performed with the least amount of strain.

It is wise to use caution in passing suddenly from a very dark to a very light room, and to avoid looking at any bright object, such as the sun, an incandescent light, white shining snow, etc., for a protracted time, through fear of deleterious effects upon the retina.

In concluding this chapter it may be well to mention the fact that the general system has much to do with the health of the eye. He who considers that the eye is a little kingdom set off by itself, with separate laws and administration, will make a grave mistake. Anything that is generally unhealthy and debilitating can have a corresponding effect upon the eye, and anything that conduces to health and vigor will assist in maintaining ocular strength and vitality. Let him, therefore, who wishes to keep his eyes in a strong and useful condition, see

that his digestive and eliminative functions are properly conducted ; that his body is not poisoned with drugs, stimulants, etc. ; that he takes an abundance of out-door exercise ; that he has plenty of refreshing sleep, and that he occasionally rests his mind and body by a relaxing vacation. In short, let him be sure that he is obeying sensible laws of hygiene, for, by so doing, not only his general health, but the usefulness of his eyes will be best maintained.

## CHAPTER V.

### REFRACTION IN SCHOOLS.

THIS is an age of prevention rather than of cure. The greatest efforts are being made to prevent disease, rather than cure it. Can anything more distinctly exemplify the disinterestedness of the physician than his earnest and unremitting efforts toward prophylactic medicine? Reflect for a moment upon the discovery of vaccination for small-pox, and the vilification endured by its progenitors and advocates. Note the active work accomplished by the medical profession in all questions involving sanitary reform and hygiene. Observe the earnestness of scientists as they endeavor to prevent the existence of diphtheria, tuberculosis, cholera, etc., by laboriously exhausting their very lives over the microscope and test-tube. No

one can deny that the existence of disease is more profitable to the physician than its absence; and yet the proudest member of our profession is he who discovers a prophylactic rather than a curative measure.

Along this line of thought one of the greatest reforms may be indicated in anything that establishes and preserves the health of the coming generation. The present generation is launched for good or for evil, and, while relief to its necessities is most urgent, it surely cannot compare with procedures that are calculated to produce in our descendants a race of people strong and vigorous in mind, body, and heart. It is for this now well-recognized principle that wise and thoughtful philanthropists are engaging, with accumulating energy, in the establishment of kindergartens, Sabbath- and mission-schools, gymnasiums, etc. They recognize the superlative importance of early training, and that the most efficient method of dealing with igno-

rance, vice, and disease is to emancipate the race from their existence.

The paramount importance of proper and well-regulated school-life becomes, therefore, clearly apparent, and educators should appreciate that in the sacred and responsible position occupied by them, it is their duty carefully to guard the body as well as the mind of the youthful generation that may be intrusted to their charge.

Without doubt many of the most distressing diseases that are incident to human existence can trace their origin to the school-life of the sufferer. Admitting that such pathologic changes are not invariably the primary and direct offspring of improper school existence, but may be the result of the submission of an already vitiated and hereditarily changed constitution to improperly-constructed and badly-managed school-buildings and school-life, we cannot, even then, as citizens, advisers, and educators, shirk the responsibility. The ten-

dency of modern civilization leads toward education and progress, and such development should be encouraged. Such advantages are shared by the rich and the poor, by the young and the old, the healthy and the sickly, by those whose ancestors were blessed with vigorous minds and bodies, and by those who can only gaze retrospectively at a line of antecedents that were cursed by the presence of dissipation and disease.

Admitting the existence and operation of a law requiring a proper medical certificate before admission can be obtained to the school, there would still be a large percentage of scholars who, apparently healthy but burdened by unfortunate inherited tendencies, are capable of development under improper and vitiated circumstances. The responsibility of the present generation to the coming one regarding school-life is, therefore, enormous, and involves such questions as the location of school-buildings, with reference to air, space, and drainage; the con-



struction of the building itself with regard to window space and the direction of light ; proper ventilation, plumbing, and drainage ; the necessity for good and sufficient artificial illumination ; the withdrawal of the tendency towards overcrowding ; the necessity for medical sanction before admittance to schools may be obtained ; the use of proper drinking-water ; the provision of separate basins, towels, and soap, which is an unquestioned source of contagion, especially of an ocular nature ; the construction of desks of different sizes for different ages, so that the pupil may firmly plant his feet on the floor, and always occupy the same relative position to his desk ; the construction of desks that are of the proper slant and height, and compel an upright position of the body in reading and writing to be taken, thus lessening the tendency to a contracted chest and distorted spine, which are prime factors in the production of consumption and spinal disease ; the frequent

intermission from studies and the change from one study and occupation to another, thus compelling a combined rest of eyes, mind, and body ; the proper regulation of the means of study, such as the distances and color of blackboards, the color of slates, the character of print, and the paper upon which the type is printed ; the necessity for vaccination ; the exclusion of contagious diseases, and the execution of advisable quarantine regulations and proper rules or laws, intended to exercise a beneficent care over the sight and eyes of the rising generation ; these, and many other subjects that are pertinent to the matter under discussion, must appeal to the consciences of those having under their control the health and morals of these young people in whose hands must shortly be placed the future of our country. The scope of this chapter must necessarily preclude the possibility of even a casual discussion of most of these subjects, and it therefore becomes necessary

to limit any remarks to observations that are pertinent to the eye during modern school existence.

The deleterious influence of education and intellectual advancement upon the human organism can not be questioned. Not that knowledge invariably goes hand in hand with physical retrogression; but uneducated and untutored races are always superior types of bodily development to those nations that are renowned for an insatiable appetite for knowledge.

The eye is no exception to the principle involved in this statement. The eyes of a people engaged in rural and pastoral occupations will demonstrate few, if any, errors of refraction; and in races of a barbaric or semi-barbaric nature, such pathologic conditions may be said to be positively unknown.

Ramas, who made an examination of two thousand Mexican school-children, found only eighty-eight myopics, sixty hyperme-

tropics, and ten astigmatics. He asserts that pure Mexicans rarely show any errors of refraction, and such deviations are almost invariably found in the mixed races. If this be compared with the statistics of the German Empire, the home of the most highly intellectual people in the world, it will be found that the most advanced seats of learning show that fifty per cent. of the pupils are afflicted with myopia, to say nothing of hypermetropia and astigmatism; and, as if this were not enough, one school in Vienna has actually produced seventy-five per cent. of myopic youths.

Unquestionably, therefore, school-life is disastrously prolific of refractive errors, and should be controlled with every means that is possible by those having such matters in charge. Moreover, while it cannot be denied that myopia is found much more frequently than hypermetropia and astigmatism, still the existence of the latter conditions must not be ignored, for they often exert an important

function in the health and character formation of the scholar. However, from the very nature of myopia, and the possibility of its extreme development under adverse circumstances, combined with its influence on heredity, it becomes inevitably the most potential factor in the consideration of the matter under discussion.

Statistics on this subject are enormous, as from the time of Cohn's investigations in the Breslau schools in 1865-66 to the present time, more than two hundred thousand pupils have been examined by competent observers for statistical purposes. These investigations have occurred in all civilized countries, and have been made under all circumstances of age, sex, race, cranial formation, health, heredity, intellectual advancement, and school architecture and management. Many of these investigations have been so arranged as to follow a certain number of pupils from class to class and from school to school. They all point

to one inevitable conclusion,—viz., that mental culture is obtained at the sacrifice of ocular perfection, and that such imperfections are usually myopic in their nature.

It is unnecessary to detail the reports of individual investigators, it being sufficient to remember that such men as Cohn, Jäger, Rüte, Erismann, Loring, Derby, Agnew, Risley, Hippel, Schmidt-Rimpler, and many others of equal eminence have contributed their time and ability to this work. Neither can additional investigation materially influence the consensus of opinion on the subject.

Certain facts have thus become established, and, as they cannot be further proved, our duty lies clearly in the line of an earnest and concerted effort tending toward, at least, a material mitigation of an existing evil. These facts may be briefly mentioned as follows:

The human eye at birth is normally decidedly hypermetropic. Herman, who ex-

amined the refraction of one hundred and ten children at about the age of three months, found them all hypermetropic without exception. Some deviations from these statements are recorded by observers who have detected myopia in very young infants by the ophthalmoscope; such instances are, however, exceptional, and, while doubtless true, are immaterial.

The eye which shows hypermetropia in later life probably never reached the emmetropic line; but the hypermetropic eye which develops myopia, has at one time assumed a condition of emmetropia, and from this point its axis has elongated by circumstances of heredity, health, and occupation.

The statement that myopia is entirely an acquired disease can hardly be substantiated when we reflect upon the many instances, observed by all ophthalmologists, where myopia will run from father or mother to every child in the family. Such cases can

not be coincidences, neither can they result from certain peculiar environments. Dr. Matais, of Angers, France, has examined the families of three hundred and thirty young myopic subjects, and has arrived at the following conclusions: 1, the hereditary influence of myopia is manifest; 2, it exists in two hundred and sixteen out of three hundred and thirty families; 3, hereditary myopia is characterized by its early appearance, its comparatively rapid development, and the high average of its degree; 4, myopia is transmitted from the father to the daughter eighty-six times out of one hundred, and by the mother to the son seventy-nine times out of one hundred.

The same author believes that myopia is inherited in sixty-five per cent. of all cases, and that hereditary myopia is more sharply defined than the acquired form. He also says that it reaches a higher degree more rapidly, and that its complications are more frequent.



Dr. M. Kirchner, of Germany, who has made exhaustive researches upon the subject, says that children are most liable to be near-sighted when both parents are myopic, less liable when the mother only is affected, and least so when the father is the source of transmission. Boys of myopic parentage are twice and girls are four times as strongly inclined to myopia as the offspring of non-myopic parents. He thinks that girls are a trifle more inclined to myopia than boys.

Schwalbe believes that the highest degrees of myopia can invariably be traced to heredity.

M. Francesque Sarcy, the well-known French critic, whose intelligence and veracity can not be questioned, has had some interesting personal experience which he reports in an interesting manner. He begins: "I was born near-sighted; many physicians assert that persons are never born near-sighted, but only become so. Science may say what it pleases; I was born myopic.

One day, prompted by a spirit of mischief, I got hold of the big silver spectacles which my father wore and clapped them on. Fifty years have passed since then, but the sensation I experienced is keen and thrilling to this day. I gave a cry of astonishment and joy. Up to that moment I had seen the leafy dome above me only as a thick green cloth, through which no ray of sunlight ever fell; now, oh, wonder and delight! I saw that in this dome were many little brilliant chinks; that it was made of myriad separate and distinct leaves, through whose interstices the sunshine sifted, imparting to the greenery a thousand forms of light and shade. But what amazed me most, what enchanted me so that I cannot speak of it to this day without emotion, was that I saw suddenly, between the leaves and far, far away beyond them, little glimpses of the bright blue sky. I clapped my hands in ecstasy, and was mad with astonishment and delight."

Sarcy undoubtedly had congenital myopia, and, in later life, he became temporarily blind. In one eye he suffered a retinal detachment, and in the other a cataract. The latter eye was operated upon, and he acquired better sight in it than ever before.

The existence, therefore, of absolutely direct congenital myopia, while rare, can hardly be doubted; and the frequent transmission of an inherited tendency in the tissues of the eye, only requiring favorable circumstances for development, is so evident that argument is scarcely necessary.

The question of the influence of race and nationality upon the development of myopia is one of some importance, and has engaged, without yet reaching a satisfactory settlement, the attention of scientists for many years.

In some races there is a greater proneness to myopia than in others. Such tendencies, however, can usually be traced to a greater intellectual advancement, which necessarily

is indicative of greater eye-strain. Cohn, for instance, when he examined the Constantinople schools found very little myopia. This, he found, was owing to the small amount of writing accomplished by the scholars, and the manner in which it was performed. The contrast between the eyes of the Oriental and the German youth is, therefore, very marked; but the probability is that the condition is due not to nativity *per se*, or to cranial formation, as stated by Stilling (who argues that a low, broad orbit favors the development of myopia), but that its absence is dependent upon indolence and inappreciation of intellectual advancement, with probable mental perversity. The view of Stilling can hardly be maintained in view of the fact that Pymska, of Dorpat, Russia, has carefully examined three hundred and thirty-eight scholars, mostly of Esthic nationality, and has found only seventeen per cent. of myopes. Since these people have broad faces

and low orbits, and the proportion of myopes is less in them than it is in the inhabitants of western Europe, Stilling's theory can not be wholly correct. Pymaska, on his part, feels that the development of myopia depends upon the demands that are made upon the eyes by modern civilization, and that it is not dependent upon the form of the cranium.

It has been said that the Jews have more myopia than other people. There seems to be no valid ground for this assumption other than can be found in the fact that Jewish vocations, the world over, are usually those of shop-keepers, money-changers, etc., which necessitate close application to books and textures. In countries where the great mass of the inhabitants turn to open-air employments and the Jew naturally gravitates towards commercial life, no surprise need be experienced if an examination of scholars shows a wide discrepancy in the development of myopia. Proof, however, fails to demon-

strate the same variance where Jew and Christian are reared alike, and where inherited tendencies from one generation to another can be estimated upon a basis of similarity.

Dor says that "the further south you go, the more normal eyes you find." This statement may not be exactly correct, and has been the subject of debate. Still, when it is observed that in countries approaching the equator, where life becomes progressively indolent, application nears a minimum, the noon-day and other siestas are frequent, and general keenness and intelligence are lacking, it becomes easy to believe that those who are nearest the equator may more nearly approach a condition of emmetropia than those who reside further away.

Callan, of New York, has examined four hundred and fifty-seven negro children, varying from five to nine years of age. In the lower schools only about one and one-half per cent. were myopic, and in the higher

about three and one-half per cent., making the average about two and one-half per cent. In the primary schools he found no myopia.

Fox has examined the scholars of the Indian schools of Carlisle, and has found only an average of two per cent. of myopia. Examinations have been made in various countries, such as North and South America, the British Isles, Germany, France, Switzerland, Russia, Italy, the Caucasian and Oriental Countries, Norway and Sweden, Roumania, etc. The result of these investigations may be stated, in the language of Cohn, to be that "in the whole civilized world, in all nations, the number of the short-sighted increases with the demands which their school makes, and from class to class."

The percentage of school myopes in our country, perhaps, does not exceed an average of twenty-five per cent., but it is constantly increasing to correspond with the requirements of an advancing civilization. This comparative myopic infrequency need not,

however, detract from national pride, when reflection is made upon the international character of our citizens. Undoubtedly, statistics taken from native-born Americans would increase the percentage, and enable us to refute the statement that there is on the earth a more industrious and studious race of people than in the United States of America.

The coincident occurrence of advance in classes and myopia is exceedingly interesting and instructive, combined, as it is, with a diminishing hyperopia in almost exactly reverse proportions. In this connection the author can not refrain from quoting the figures of Erismann, who, in 1871, examined four thousand three hundred and sixty-eight St. Petersburg scholars. They are as follows :

CLASS.	1.	2.	3.	4.	5.	6.	7.	9.	10.
Myopia . . . .	13.6	15.8	22.4	30.7	38.4	41.3	42.	49.8	41.7
Hyperopia (Hypermetropia) .	67.8	55.6	50.5	41.3	34.7	34.5	32.4	36.2	40.



The almost invariable increase of myopia and the similar decrease of hyperopia from class to class are striking in their accuracy. The apparent discrepancies in the latter classes may be due to the fact that as a class approaches graduation, its number usually diminishes, thus producing a different proportion in percentages. The table of Erismann practically corresponds with others prepared on this subject, and is an impressive comment upon the effect of modern civilization upon ocular refraction. It also tends to confirm the belief that the very cause which produces myopia diminishes hypermetropia.

If the physical condition of a myopic eye is an elongated axis, the question may be asked what are the abnormal circumstances which produce such elongation, irrespective of whether the eye has a natural myopic tendency or not? Most text-books furnish an explanation of this phenomenon, but the most comprehensive that the author finds is

given by Fenner. I take the liberty to quote his words: "They (the scholars) usually sit bending over a desk in a stooping position; the abdominal organs are compressed, preventing the free return of the blood from the head; the insufficient illumination at many schools and colleges necessitates the bringing of the eyes very near the book, so as to obtain a larger visual angle; and, as the book usually rests on a desk or table, the head has to be bent over; this posture produces an increased flow of blood to the eyes, while the higher degree of convergence necessary causes an increased pressure of the lateral recti muscles on the equator of the globe, thus increasing the intra-ocular pressure. The congestion of the fundus oculi causes softening of the scleral tissue, which gives way under the increased pressure, and the organ is elongated backward (posterior staphyloma); the other portions of the sclerotic coat are supported by the broad muscles. The retina is then pushed back-

ward, behind the focus of the dioptric apparatus. When this condition once begins, all the causes which first gave rise to it act with increased force; there is a greater stooping posture necessary, because the eyes have to be brought still nearer to the object; an increased convergence is demanded, and the congestion of the fundus oculi increases; consequently, the softening processes progressively augment, causing the posterior portion of the sclerotica to yield more and more; hence myopia is usually progressive, particularly in the higher grades. There is a greater tendency to the development of this condition in youth from the causes above mentioned, because then the scleral tissues are softer, and consequently more yielding than in later life. With the increase of age this coat hardens, becomes firmer and better able to withstand intra-ocular pressure; hence it is rare that posterior staphyloma, giving rise to near-sightedness, begins after the twentieth year of life."

Consideration must now be turned towards those conditions of school-life which encourage and perpetuate the production and spread of myopia. The first item that claims attention is, that children should not be placed in school at all unless their general health is sufficient to endure the strain. It is unnecessary, and space does not permit the author to impress upon physicians the importance of this assertion, and the great influence exerted upon the eye by the general condition of the patient. It is, however, unquestionably imperative that medical men should emphasize the truth to the laity, and especially among those families committed to their care. We are, at present, dependent upon personal influence and the intelligence of those people not medically educated, to exclude from our schools those children who are not physically prepared to enter. The time should and undoubtedly will come when every scholar will not only be compelled to show a doctor's certificate before

entrance, but will find it necessary to produce a similar document at the beginning of every school year.

What, then, are the conditions of school-life that directly aid in the encouragement and perpetuation of myopia? First of all, the building itself should be so constructed as to present as few obstacles as possible to the proper exercise of the ocular function, and to give the pupils all the advantages that are possible in the way of location, space (inside and outside), heat, ventilation, plumbing, general cleanliness, water, basins, and soap.

The building should be lighted properly and sufficiently, as there can be no question that a paucity of illumination necessitates a closer apposition of books, which, in its turn, means increased convergence and an encouragement of myopia. Just seeks to controvert this statement by claiming that there is no decrease in myopia in the new and well-lighted schools of Zittau, Saxony. The ex-

perience of others will scarcely support him in his position. For instance, in Coburg, Germany, two thousand three hundred and twenty-three children were examined in 1874, and showed an average of twenty-one per cent. of myopia. The same number examined in 1877, after better lighting and seating had been provided, showed an average of only fifteen per cent. of myopia. De Metz, of Antwerp, has found only about two per cent. of myopia in well-lighted schools, as contrasted with five per cent. in badly-lighted schools. Other statistics, even more striking than these, might be produced to show the importance of proper illumination, but it is scarcely necessary, as the principle must commend itself to the mind of any one who gives the subject even casual attention.

The light in the school-room should be direct, and not the indirect illumination from the walls of some adjoining building. It must be constant. Dependence should

not be placed upon the immediate rays of the sun, and, for this reason, the windows should face the north. The most remote portion of the room should be bright, even on dark days, to the extent of receiving an illumination that is equal to ten candle-power. Every scholar should, from his place, be able to see some portion of the sky. Light should come from the left, and as high above the scholars as the ceiling will admit. The total window surface should bear to the area of the floor a proportion of one to five, and the panes should be as large as possible. It would be better if artificial illumination was never used, but if it is, a profusion of incandescent electric lights is the best substitute for daylight. The lights should be ample in number. They should be properly shaded, and brought sufficiently close to the desk to afford an abundant illumination. Such artificial light is superior to gas, kerosene, etc., as its color is whiter and it is capable

of uniform distribution and concentration. It does not heat or vitiate the atmosphere.

The question of the construction of seats and desks is one of great importance. Seats should permit each scholar to rest the feet squarely upon the floor, thus favoring a natural and upright position; for this purpose it is necessary to provide seats of different sizes for individual pupils, who should be seated according to their height. The desks should have comfortable backs. They must correspond in size to the pupil, and have a slightly slanting top. The tops should be situated far enough away from the head of the scholar (when seated in an upright position) not to necessitate close approximation of the page of a book to the eyes. Many seats and desks are so poorly constructed for the needs of the individual student as to just allow the head of the patient to emerge from the top of the desk, thus necessitating an enormous convergence when attempts are made to study. These defects are usually



observed in primary departments, where full-sized desks are employed by very small pupils. Strict rules are enunciated by Fuchs and others as to the relation that should exist between the desk and the seat. Fuchs says that "the proper position is that in which the shoulders and pelvis are parallel with the edge of the desk, and the head upright or bent but slightly forward. As to the construction of desks and seats, there must be several sizes, to suit scholars of various ages. The vertical distance between seats and desks must be but little greater than the distance between the elbow and the ischial tuberosity. The edge of the desk must overhang the seat about two inches; the scholar can then sit upright."

Rohe does not think it necessary for the desk to overlap the seat, but says that "a line dropped from the near edge of the desk should strike the front edge of the seat."

In any event the object is, if possible, to prevent stooping and to compel the scholar

to study in an upright position. Various apparatuses have been constructed for the purpose of forcing an erect attitude, but as yet nothing satisfactory and practical has been proposed.

Attention should be given to the distance and location of blackboards, to prevent their being placed at so great a distance from any scholar as to necessitate a strain in order to see, and also carefully to avoid a position where rays of light will be reflected upon their surface in such a manner as to obscure the characters that are inscribed thereon. Similar care should be given to the placing of maps, from which scholars from time to time are required to study. Some investigators believe in doing away with the blackboards entirely, and substituting white surfaces and black crayons, they believing that black writing on white background can be read at a greater distance than the reverse. In some schools the same plan has been proposed and practised with slates; white

slates and black pencils are used on account of lessened reflection. Good results are claimed. Owing to the glistening surface, other investigators believe in not using slates at all. They would substitute paper and pencil or pen, the paper to possess a non-glistening surface and to be thoroughly opaque.

School-books should be of a size that can be easily handled. The paper should be reasonably thick, of good quality, and have a dulled surface; some authorities think that yellow instead of white paper is to be preferred. The Latin letters are best for all kinds of reading, and it is certain that if Germany would absolve itself from nationalism sufficiently to declare an emancipation from its miserable type, there would be less myopia in that country. The letters should be well printed, and they should be clear, distinct, and large. Cohn insists that all books should be prohibited from schools in which a smaller type than long primer,

a less interval between the lines than one-tenth of an inch, a longer line than four and one-half inches, and containing more than sixty letters to a line, are used.

The question of erect or slanting handwriting is one that is much agitated at present. In the first place, Ellinger opposes the practice of inclining the copy-book to the right instead of straight ahead, feeling sure that it favors the development of myopia. However this may be, it is certain that there is variety in the opinions that are expressed relative to the preference as to erect or slanting writing, with the drift of sentiment favoring the former. Berlin favors the inclined writing, but he appears to be occupying a somewhat isolated position. Shubert, Manz, Königshoefer, Seggel, and others endorse vertical handwriting. It is felt that the oblique system favors myopia by an unnatural position of the head, and by the fact that upright writing is usually clearer and more easily read than the ob-

lique. As continuous work is detrimental to the health of the eye, this should be avoided in the school by often changing from one occupation to the other, as from desk work to recitations, and by frequent intermissions, during which time the rooms should be thoroughly aired. Matais claims that at the Military Prytanaeum and at the School of Arts and Industry, at Angers, myopia is relatively rare, although the hygiene is not better than in the colleges. He claims that this exemption is dependent upon the frequent interruptions in work, which consist in manual work, games, and active exercise.

Unquestionably, much harm is done by indiscretion in ocular service at home. Granting that our directors performed an elimination of all existing school evils relative to ocular hygiene, there would still remain an element in the abuses at home that is beyond their control. Here there is a mere repetition of all the evils that have already

been enumerated as occurring in school-life. Here provisions are not usually made as to proper desks and seats, light, and interruptions in work. Children are allowed much latitude as to what, when, and how they read. Poorly-printed novels are absorbed before and after going to bed. They are read whilst the child is either sitting or reclining. Any light that happens to be convenient is used. In view of such inevitable abuses, especially among the poor and ignorant, the warfare against myopia is not of an encouraging character. This should not, however, absolve us from pressing the battle whenever an opportunity presents. If perfection cannot be obtained, progress can at least be made, and much benefit will accrue from educating school-directors, teachers, and the laity, who can, in their turn, perform their part in disseminating knowledge upon the subject among those who are less informed than themselves.

As a rule, children are sent to school too

early in life, and too little attention is paid to the individual adaptability of the child for school-life and its requirements. Again, it is felt that a child must go to school at a certain age, irrespective of his physical condition, and such generalizing of educational methods is frequently followed by exceedingly detrimental results.

Children often go into kindergartens with perfect refraction, and acquire myopia even before entering the primary department of a public school. The use of the eyes at a tender age, especially in those children who inherit a myopic, tuberculous, or scrofulous tendency, is exceedingly hazardous. Their tissues are soft, pliable, and yielding, particularly where such parental predispositions exist. In such cases the confinement and bad school hygiene, coupled with the desk- and eye-work that are incident to school-life, unquestionably form a combination of circumstances that conspicuously favor the development of myopia.

Myopia is rare before the eighth year of life. It usually begins about the tenth year and reaches its maximum at about the twentieth year. As statistics show that the less educated the nation, the more cases of normal refraction are found, it must be self-evident that these early years of life should be guarded from the refining influences of intellectual advancement as much as possible. In other words, it should be borne in mind that it is better to devote the years of youth to laying the foundation of a strong constitution, and that the rural child, raised upon the farm, with practically no advanced educational advantages until about the fifteenth year, often far outstrips his city rival, whose life has been spent in kindergartens and other graded schools.

The question as to what shall be done with these children of perverted tendencies is one of great importance. Shall they be sent to the public school at the average age, to be thrown into the common receptacle, to be



assigned the same lessons, and to be treated in exactly the same way as the youth of untainted health and robust constitution? Common humanity unhesitatingly answers in the negative. Such children should rather be allowed to spend their lives in the open air, with a judicious intermixture of properly-assigned manual labor. Their mental education should be postponed, and every effort made to mitigate the unfortunate tendencies of birth, by inducing a physical rather than an intellectual life; one that should be preferably spent in the country, where the air is good and the surroundings are healthy. Systematic study should not be begun until about the fifteenth or sixteenth year, after the body is thus strengthened, and the ocular tissues have grown firm and better able to resist the encroachments of myopia. Even then it will be better to teach the child at home, or at some private institution, where its student life can be better controlled.

It may be urged that such advantages are only for the wealthy, and the question may be asked as to what must become of the myope situated in humbler circumstances. This query may be exceedingly pertinent, but it must not be forgotten that the compensations of life are somewhat evenly divided, and that myopia is much more prone to occur among the wealthy and intellectual than among the poor and illiterate. Consequently the necessity for such restrictions in the early career of our youth will not so often be required of the latter class.

Can myopia be cured? This is a question which is forced upon us, and must be conservatively answered. When once thoroughly established, and decided organic changes have occurred, the probability is that with our present knowledge of the disease it can not be cured; it can only be alleviated. That by improved school hygiene, education of the laity, and careful and uniform correction of refractive errors,

it is susceptible of material mitigation in a community is amply proved by the careful and painstaking investigations of Risley and his associates in Philadelphia. It must ever be borne in mind, however, that the only reasonable hope for even partial emancipation must necessarily rest in prophylaxis, school hygiene, an intelligent co-operation of the laity, and a proper correction of the refractive error by suitably adjusted glasses.

While the subject of myopia in youths is of signal importance, we must not lose sight of another class of cases,—viz., the hypermetropes and astigmatics. These, it is true, do not possess that element of danger to sight found in malignant myopia, where the disease marches on to posterior staphyloma,\* detached retina, and blindness; but it does mean much in the possible intellectual prog-

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\* Posterior staphyloma is a posterior bulging backward of the eye, found in extreme myopia. In this disease the retina sometimes becomes detached from the underlying choroid.

ress of the individual, and the attainments of those heights of knowledge that are apparently demanded by modern civilization.

The myopic eye is often a strong eye, capable of performing much work at short range; but the hypermetropic or astigmatic eye possesses attributes that are quite the reverse,—viz., comparative ease in distant vision, but great inconvenience during close work. The hypermetropic or astigmatic youth suffers from symptoms, such as headache, eye-tire, etc., generally classed under the one term, *asthenopia*, and which have their principal origin in an overtaxed ciliary muscle. He goes to school, but takes no interest in his studies; he is called idle because he gives so little attention to his books; he is classed as stupid from never knowing his lessons; he is thought to be a complainer because he frequently has headaches; he taxes the patience of both the teacher and the parent, whose wonder is excited when the inane, idle, stupid, fault-

finding child is transformed into a wide-awake, industrious, healthy student by the aid of a properly-adjusted pair of spectacles. This is an experience that is common to every teacher and physician, and the frequency of its occurrence should be an incentive to active efforts for relief upon the part of those from whom relief is expected to come. An important matter of this nature can not with safety be left to the laity to settle. Some means must be devised by which an ocular examination of each scholar shall be a requisite for entrance into a school, and by which a repetition of such an examination must be made at stated intervals during the scholar's school-life. Opinions differ as to the necessary frequency of such tests. Some feel that they should be held every six months, and others that an annual examination is sufficient. Either plan would be an improvement upon the present system, where nothing of the kind is required.

In addition to this, provision must be made by which children who shall be adjudged to possess defective eyes shall be required to produce a proper certificate from a reputable physician before admission to the school is permitted. Such a specification would exclude work so commonly done by opticians, jewelry and department stores, etc.

One method would be to have a competent physician appointed by the proper authorities, whose duties should be to pass upon the eligibility of all scholars, both upon entrance examination and at stated intervals. This would, however, be open to certain objections. It would involve a salary, which the different boards might be unwilling to pay, and would inevitably impair the efficiency of such a law by a degeneration into political jobbery. Besides this, the appointee would undoubtedly be distasteful to many pupils or parents, which would constitute an obstruction to harmony and an embarrassment to the examiner.

In case such a method is deemed inadvisable, another plan would be to require of each pupil a proper certificate from a reputable physician, stating the ocular condition of the applicant, with recommendations for relief if necessary. This, again, would be opposed by the people as compelling an ocular examination where it is perhaps unnecessary, thus incurring a useless expense to parents or guardians. It is true that a combination of both of these methods might be adopted, and a law passed requiring that each pupil shall pass an ocular examination by a physician, leaving it optional, however, with the parent or guardian whether the child shall be passed upon by the school-examiner, or taken to a physician of recognized standing whom they themselves shall select. This would be a compromise measure, but would still be open, in mitigated form, to the combined objections of both procedures.

There is another method of dealing with

the subject, elsewhere proposed by the author, which may not be considered sufficiently stringent and scientific for enthusiasts on the matter, but which he believes to be all that can be accomplished at present, and may pave the way for something more energetic in the future. It can be executed at practically no expense to our school treasury, will but seldom cause useless expense to parents and guardians, can be universally applied, and, if thoroughly accomplished, will give general satisfaction. The idea is simply to have a physician of recognized ability deliver a lecture or talk on the subject to the principals of the city schools once a year, just preceding the opening of the schools. This talk should include plain and comprehensive remarks upon the anatomy and physiology of the eye, refraction, and how to use, but not abuse, the eyes in school- and home-work. It should also be arranged to instruct the principals how to test the eyes, in accordance with some scheme similar to



the subjoined. Besides this, printed directions for testing the eyes, reading something like the accompanying, should be given to each principal.

#### INSTRUCTIONS FOR EYE EXAMINATIONS.

The examination should be made privately and singly, in a room set apart from the general school session.

A card of Snellen's Test Types is to be placed on the wall in a good light; the face of the card should not be covered by glass.

The line marked xx (20) should be seen at twenty feet, therefore the pupil is to be placed twenty feet away from the card.

Each eye should be examined separately.

A card should be held over one eye while the other is being examined.

The covered eye should not be pressed upon, as the pressure might induce an incorrect examination.

The pupil should begin at the top of the test-card, and read aloud down as far as he

can ; first with one eye, and then with the other.

If the pupil can read xx (20) test-type with each eye, and does not, upon inquiry, complain of tired and painful eyes or headache, he may be admitted to school ; but if he can not read xx (20) test-type with both eyes, or complains of tired and painful eyes or headache, he should be sent home with a card of information, such as the accompanying, to the parent or guardian :

— —, 18—.

DEAR ———,—Your son, ———, has been examined by me this day as to the condition of his eyes.

I believe it to be advisable for him to consult a physician of recognized standing, from whom he should bring a certificate stating that it is wise for him to continue his studies.

Respectfully,

—————, ———,

Principal of ——— School.

The test-cards, the printed cards of instruction for principals, and the blanks to

be sent to parents or guardians would all cost but little ; hence the expense would be unobjectionable. Besides, the test is so simple and so easily accomplished that any principal of a school could soon master it and examine the pupils with such ease and rapidity that a large school could be tested in a very few days. If systematic arrangements were made, an average of two or three minutes to each pupil would be all the time that would be necessary.

The author is aware that such an examination is not ideal and is open to objections ; but he believes that it is better than nothing ; that it is fairly sufficient ; that it can hardly antagonize interested parties ; that it can not savor of medical favoritism ; that it involves practically no expense ; and that it is so simple and practical that it commends itself to all.



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